factory
MANAGEMENT AND MAINTENANCE

Vol. 94, No. 12 — December, 1936

CONTENTS

Look at These New Wage Plans. An editorial — 35

Striking Against Strikes — 36
Good advice from a successful mediator

1936 Personnel Trends — 39
Results of a survey of 64 companies

Build Today's Plant for Tomorrow, Too — 40
A plea for the "extensible" factory building

Fifteen Months More of Paying by the Year — 43
Latest news about Hormel's straight-time plan

Your Inventory a Graveyard? — 45
Blame only yourself if it is

Revamped Our Shipping Room for Group Bonus — 46
Pro-phy-lac-tic stores stock on roller conveyors

Work at Work Level — 48
They team monorail and overhead chain at Packard

Teach It with Pictures — ~~49~~ 50
"Stills" make instruction sheets more useful

"Where Dad Works" — 52
A steel mill invites the neighbors in

You Want to Know — 53

Spot Welding Quality Isn't Up to the Operator — 54
National Cash Register solves human equation

We Have to Use Instruments — 56
They give Bethlehem Steel the facts

Pick Floors for the Job You Ask Them to Do — 59
Shall they be concrete, steel or wood?

X-Rays Tell the Inside Story — 61
They look into everything from candy to boilers

Again We Say: Watch That Power Factor — 63
It may cost you money without your knowing it

Operating Shorts

Two Pulleys Needed, Room for One — 65
When Quarter-Turn Belt Drives Give Trouble — 65
One Man, One Day, Reclaims 600 Gal. of Oil — 66
Manager Moves to Men in His Steel Office — 66
Where a Trip Saves a Smash — 67
Effective Control of Stockroom Lighting — 67
Fewer Men, Fewer Accidents — 67
When Cutting Corners Is Profitable — 68
Watching Idle Materials Reduces Spoilage — 68
Envelope Keeps Orders, Blueprints Together — 68

Flashes from the Equipment Makers — 69

What's New in Equipment — 70

Trade Literature — 74

Books — 74

Questions and Answers — 76

FACTORY'S PLANT OPERATION LIBRARY

Personnel Management — S333 — S344 — Preceding Back Cover

MASON BRITTON, *Senior Vice-President* — L. C. MORROW, *Editor* — A. M. STAEHLE, *Manager*
G. A. VAN BRUNT, LEWIS K. URQUHART, *Associate Editors* — C. G. SMITH, J. F. ANDREWS, *Assistant Editors*
A. H. MOGENSEN, ARTHUR VAN VLISSINGEN, JR., *Consulting Editors*
H. P. DUTTON, *Chicago* — CHARLES B. GORDY, *Detroit* — PAUL WOOTON, *Washington*

Factory Management and Maintenance is a consolidation of *Factory and Industrial Management* (including *"Factory"*) and *Maintenance Engineering*

Price 35c. a copy. Subscription rates—United States, Canada, Mexico and Central and South American countries, $3 a year. All other countries, $4 a year or 16 shillings. Cable address "McGrawhill, New York." Member of A.B.P. Member A.B.C. Copyright, 1936, by McGraw-Hill Publishing Co., Inc.

Factory Management and Maintenance, December, 1936 Vol. 94; No. 12. Published monthly. McGraw-Hill Publishing Company, Inc. Publication office, 99–129 North Broadway, Albany, N. Y. Editorial and executive offices, 330 West 42d Street, New York, N. Y. Entered as second class matter, November 13, 1936, at Postoffice, Albany, N. Y., under the Act of March 3, 1879.

JAMES H. MCGRAW, JR., Chairman — MALCOLM MUIR, President — JAMES H. MCGRAW, Honorary Chairman
MASON BRITTON, Senior Vice-President — B. R. PUTNAM, Treasurer — D. C. MCGRAW, Secretary

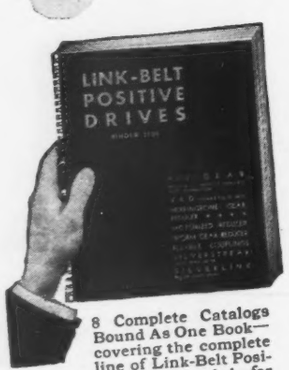
Branch Offices: 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, Aldwych, London, W. C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta.

● "It surprised me, too, but it's a fact. I always knew they were *better* than belts—because they can't slip and waste power—but when I found out they were *cheaper,* I didn't lose any time putting them in."

Hundreds of executives responsible for keeping production up and costs down have made this interesting discovery and have switched to Link-Belt Silent Chain Drives. Measured over a period of years, their cost is infinitely lower than belts — but often even their first cost is less.

And, in addition, Link-Belt Silent Chain Drives have many other advantages; they transmit full speed and power, assure a uniformity of product, maintain production, save space, require no attention, are smooth and quiet in operation, and their life is measured *not by years but by decades.*

Made for any horsepower and stocked in sizes up to 60 H. P. Ask for Pink Stock List No. 1725. Link-Belt Company, Indianapolis, Philadelphia, Chicago, Atlanta, San Francisco, Toronto. Offices in principal cities. 5798



8 Complete Catalogs Bound As One Book—covering the complete line of Link-Belt Positive Drives. Ask for Binder No. 2100.

LINK-BELT
*SILVERSTREAK
SILENT CHAIN DRIVES

★ T. M. REG. U. S. PAT. OFF.

LINK-BELT *positive* DRIVES INCLUDE

SILENT CHAIN DRIVE

ROLLER CHAIN DRIVE

P.I.V. GEAR SPEED VARIATOR

V.R.D. VARIABLE ROLLER DRIVE

MOTORIZED REDUCER

HERRINGBONE GEAR REDUCER

WORM GEAR REDUCER

Factory
MANAGEMENT AND MAINTENANCE

L. C. MORROW
Editor

Look at these New Wage Plans

LAST MONTH'S election proved that employer-employee relations is to continue to be a major problem of management.

Strikes are predicted by numerous analysts. Yes, strikes will come. Why not? Industry's employees have been told forcefully and often that they should have shorter hours and higher pay.

True, the record shows that the manufacturing industries, for example, have made no killing in the way of profits. But the proponents of sudden redistribution of income say that profits would be high if the capital structure of industry's units were dried out.

Thus, so far as argument goes, there is a draw.

So, at this juncture, some companies are revising payment methods to put the employee on a partial profit-sharing basis. Other companies acted along that line some time ago. We cite examples of both.

The most recent payment method, just adopted, is that of the United States Steel Company. It provides for increases or decreases in pay as the cost of living index of the U. S. Bureau of Labor Statistics rises or falls within certain limits.

A similar plan, effective October 1, was adopted by the General Electric Company.

On May 1 the Westinghouse Electric and Manufacturing Company put into effect a new plan. Increases and deductions in relation to wages and salaries normal to the community depend upon increases or decreases in company earnings.

More than a year ago the Nunn-Bush Shoe Company adopted a plan by which every employee was put on an annual salary that guaranteed him 52 weekly pay checks during the year. The pay checks are subject to upward or downward revision if the company's gross income, or total sales, varies materially in either direction.

For almost three years George A. Hormel & Company, meat packers, have been paying employees a weekly wage based on annual production.

STILL ANOTHER method of increasing employee incomes is the paying of bonuses as increased earnings permit, exemplified by recent action of Chrysler, Standard Oil of New Jersey, General Motors, and others.

Industry was the first to recognize the need for purchasing power on the part of the people in the lower income brackets. Industry, of itself, adopted the high-wages-short-hours policy. In adopting the wage plans described, specific units of industry are now showing evidence of industry's ability to solve the new problems that are a part of the conditions of today.

Obviously, the nation and its industries are prosperous in proportion to the number of the nation's people that are prosperous. So, wide distribution of wealth — consisting largely of industry's products — is essential. What we can't do is to distribute that wealth before it is created. For that reason, plans looking toward the sharing by employees of industry's prosperity *and* its adversity seem to promise much in the way of satisfactory employer-employee relations. They should be widely understood and considered, perhaps adopted by many units of industry.

It can't happen here! Many a complaisant management feels that way about the strike in the other fellow's plant. But it did happen there, and it can happen in any plant so long as men and management won't be reasonable

Strikes are never twice alike. One cannot say this must be done, that must not be done. But there are fundamental moves that management can make to lessen the strike possibility. Who better than Ralph Lind, an unusually successful settler of industrial disputes, to tell us what those moves are?

Striking Against Strikes

RALPH A. LIND

Regional Director, National Labor Relations Board
Cleveland

WERE all strikes alike, with the same underlying causes, with the same immediate demands and counter-proposals, and with the participants temperamentally the same, it would take no inventive genius to lay down a set formula for settling every industrial disorder in America. But it is exceedingly doubtful whether any two strikes *are* exactly alike. Different factors enter into almost every one. Even two strikes in the same plant within a short period of time probably differ in at least one respect, if not more than one, and every different factor is important to employer and employee.

For that reason it is almost impossible to outline a set of strict rules to be used when a strike is threatened or has been called. There can be no handy manual for use in case of disorder. One cannot say *this* must be done and *that* must not be done.

There are, however, several fundamentals of management that, when followed, lessen what might be called the "strike hazard." That there *is* a "strike hazard" in almost every industrial organization cannot be denied. No matter how amicable the relations between the employer and his employees, no matter how long the plant has been free from disorder of any kind—there is always the possibility, however remote, that sometime there may be a strike in that plant.

Certain general rules that should be apparent to every employer, but often are not recognized in the rush of business, may be cited as making for continued good will in any industrial organization, no matter how large or small:

1. Maintain wages and working conditions at the rate prevailing in the industry.

2. See that there are no grievances in the plant. Grievances prey on the minds of workers. They should be heard by someone in authority in

a spirit of friendliness and helpfulness. Encourage employees to confide all their difficulties relating to the shop to someone who can adjust them. In a small plant it would no doubt be the superintendent; in a large one, the employee's foreman or immediate superior.

3. Superintendents and all those in charge of production should cultivate the ability to sense discontent. Decreased production resulting in increased scrap, more than the usual amount of bickering and consequently more loafing, are two sure signs. Sometimes discontent is not readily apparent, but the forward-looking employer can create a spirit of confidence that will pay dividends in nipping the cancerous growths that result in strikes. This is not meant in any way to encourage a spy system, which defeats its own purpose by breeding lack of confidence.

Lives of Their Own

4. Remember that workers have lives of their own and that they have families. Be as considerate as possible of employees, working them overtime only when it is absolutely necessary. The loyal employee who has confidence in the management will gladly work overtime when he is asked because he knows he would not be asked if it were not imperative. Present-day workers, especially those organized, do not care about overtime with its extra pay; they are anxious to spread available work out as far as possible.

Several stories of Ohio strikes may shed some light on the causes of industrial disorders and what may be done after strikes are called. The mistakes of both sides should be apparent, and it should be comparatively easy to determine how they might have been prevented.

Strike A was in a plant employing about 300 men and women, most of them foreign born. At the time the strike was called the union demanded a closed shop, union recognition, wage increases, a 40-hour week, seniority rights, time and a half for overtime, a guarantee against discrimination for union activity, and certain minor adjustments in working conditions.

The company, with its union employees out and the plant heavily picketed, denied in full every demand, asserting that the employee representation plan was a true collective bargaining agency and that it would not deal with an outside union.

So far, not so good. The two sides are completely at loggerheads and the machinery for settling the strike can be put in motion.

But in this particular instance it was not. No attempt had been made by either side prior to the calling of the strike to adjust the dispute. Neither side, for instance, called on a government mediation agency when it became apparent that conferences between the union shop committee and the management were widening the breach. Likewise no appeal to disinterested parties was made after the strike was in effect.

Then, to add to it all, violence of a significant nature occurred two days after the strike was called. A non-striker, a woman, was pushed into the path of an automobile by a group of women. Explanations that followed indicated that the fact that she had continued at her job was not the only reason for the attack. There was evidence of long-standing ill feeling between outside union and so-called "company union" members. For weeks before the strike there had been "union talk" in the plant, arguments among the workers at lunch hour and at the benches. There was also evidence of face slapping and hair pulling among women workers during working hours.

To Prevent Violence

The company immediately sought a court injunction to prevent violence and limit picketing, and was challenged by union representatives who said the company had violated and was still violating the NIRA—which was then in effect—by offering to negotiate only through an outsider privately retained for that purpose.

In the court hearing that followed there was testimony under oath that foremen and others had circulated through the plant quietly warning workers that they would lose their jobs if they joined the outside union. A minor executive was alleged to have made a speech to a group of women employees during a lunch hour in which he warned against the outside union.

As the hearing continued, the two

Ewing Galloway, N. Y.

Employer-employee problems are practical problems for which practical solutions must be found. Men have confidence in the management that tries to find out what these problems are and then sits down with the men to determine the practical solutions to them. And few men will turn on the management in which they have complete confidence

sides became more bitter. The strike had been in effect three weeks. Production was practically at a standstill, although the plant was kept open.

Although at no time officially asked by either side to enter into the dispute, the Cleveland office of the National Labor Relations Board was familiar with the situation, and on the twenty-third day of the strike I unofficially asked representatives of both sides to meet with me. I had been away from Cleveland three weeks and extended the invitation at the first opportunity after returning.

Both sides agreed to meet, although they were in no sense high-pressured. A few hours after the first conference started, word was sent to the courtroom where the injunction hearing was in progress that an agreement might be expected. The hearing was adjourned by the court; the agreement was reached that night and ratified the next day by the union. The plant was opened and was again operating normally within a day or two.

What happened to cause the sudden change? Obviously, both sides were anxious for a settlement. Obviously, to obtain one, both sides were forced to make concessions. The immediate problem was to get the men and women back to work. In this case it was done through an agreement calling for negotiation of the principal points in dispute within one week after the return to work. With the two sides feeling as they did toward each other, it was necessary that the negotiation agreement be one in which both sides would have confidence that their positions would be heard completely and fairly.

Terms of Final Settlement

In agreeing to negotiate the dispute, the company called off the injunction proceedings, and the union withdrew its pickets.

Now note the final settlement. A scale of wage increases was drawn up, not a blanket wage increase as demanded. The closed shop was excluded, and the union was empowered to act for those employees who were members. A scale of maximum working hours not in excess of 40 hours in slack periods and 44 in peak periods, was worked out. Strikes and lockouts were definitely excluded by a clause providing for arbitration in the event any dispute could not be settled through direct negotiation. The company agreed not to discriminate against any employee for union activity.

And further, the president of the company agreed to meet at a stipulated time each week with a union committee "to discuss grievances and receive suggestions."

There has not been a dispute since then that has not been amicably adjusted by direct negotiation between the company and the union. The arbitration clause has not been used. Production is higher than it has been for many years. And reports indicate that the morale in the plant is better than it has ever been in the history of the concern.

If it is necessary to have a strike to bring about such laudable adjustments, then Strike A could be called worth while. But there is every reason to believe that the same result could have been obtained without the financial loss to both sides and the period of bitter hatred.

Why the Mediator

Had either side applied to the government agency, it is possible that the same methods used to reach the final settlement might have been used with equal success before the strike started. It is, of course, sometimes easier after a strike has been in progress three weeks to persuade each side of the value of taking a reasonable attitude. In almost every strike each side must eventually yield some things. When both sides have made enough concessions, they find themselves so close to complete agreement that those things not yet settled can be adjusted without difficulty. It is in suggesting possible concessions and thus gradually bringing the two together that the experienced mediator shows his value.

Strike B was recent and had no connection with the NRA, wages, or the ordinary union demands.

The plant employed about 500 men, of whom 43 were union members at the time of the strike.

One morning, as the night shift was leaving, the men were informed that owing to an unexpected order they would be required to return in six hours. The work was to be overtime, for which they would be paid the regular rate of pay.

Without creating a disturbance, the men let it be known that they would not return. Six hours later only one of the more than 25 men on the night shift appeared for work.

Those who had not returned were notified by special delivery letter that they were discharged. The next day a desultory picket line was established by the discharged employees, and by personal contact nearly every worker in the plant was persuaded to quit. Then an appeal was made by the unorganized men to the union nucleus for help, and although the union had no particular interest in the dispute, since none of its members was discharged, it agreed to do what it could. In return, about 375 men joined the union in that one day.

Ready to Fight

With the plant unable to operate because of lack of man power, the company offered to take back all its employees, regardless of whether they had been among the original group that refused to work. But the management reckoned without the union. Through union spokesmen the men said, in effect: "We don't want this to happen again and we want some concrete assurance that it will not. We have a strong union now. We're prepared to fight and we want an agreement."

The management refused to deal with the union, saying that its offer was simply that the men could return to work.

The union, in turn, appealed to my office, saying that the company refused to bargain collectively and asserting that it would file charges with the National Labor Board.

A conference was arranged at which the company agreed to bargain collectively with those of its employees who were union members. Working conditions were stipulated in a contract signed by both parties.

Strike B could doubtless have been avoided, but it is illustrative of the abuses that are sometimes heaped upon unorganized workers simply because they are unorganized. The union had been unable to gain any appreciable headway during its three years in the plant. It took a particularly flagrant violation of one of the fundamentals of employer-employee relationship to precipitate the strike. Had it been the first time that the men were asked to work overtime at short notice, there probably would have been only muttering. But there had been numerous opportunities for the men to mutter and complain of their lot among themselves.

Through the action of an unor-

(Continued on page 78)

1936 Personnel Trends

DONALD S. PARKS
Personnel Director, University of Toledo

ABOUT two and a half years ago a class in personnel management at Toledo University conducted a survey of personnel practice in representative firms. The results of this study were published in *Factory* (May, 1935, page 201). This study was repeated last June. The results are summarized below.

Questionnaires were sent to 154 representative manufacturing companies, well distributed as to industry and location. Returns were received from 81, of whom 64 supplied data on number of employees. The companies ranged in size from several with less than 500 employees to concerns employing over 25,000, the typical or median company employing from 1,000 to 2,000 persons. The data in the table below is based on the 64 companies, which reported a total of 309,317 workers.

Subject to inevitable limitations in the interpretation of questionnaires, certain tendencies stand out fairly clearly from the study. The use of application blank and interviews in hiring, personal introduction to the job, instruction on the job, group, accident and health insurance, first aid stations, and some plan of financial aid or loan to employees seem to be well-nigh universal.

For Big Companies Only?

As can be told by comparing percentage of employees with percentage of companies, certain practices seem to be more widely used by larger companies. Examples are time and motion study, foremanship training, pensions, clubs, plant papers, reading rooms, employee representation, and legal aid and advice to employees.

Significant increases are noted in job analysis, the use of rating scales, the personal introduction of the employee to his job, follow-up and periodic interview to check his progress, participation in college cooperative programs, social activities such as athletics, dances, and clubs, the use of employee representation plans, systematic interviews for grievances, and the growth of unions. Although still comparatively small, the use of the sponsorship program for training has doubled since 1929.

Two significant decreases stand out. Companies still using stock purchase plans number less than half those of 1926, and there has been a slight decrease (as would be expected, in view of impending state legislation) in pension plans.

Altogether, the survey shows that more attention is steadily being given to organized personnel procedure. Many of the practices that were innovations in 1929 are growing into general acceptance today. Although cyclic influences tend to affect the use of many of the procedures (as is shown by the "dropped" column), all of the personnel methods and plans listed, except plans for sale of company stock to employees, seem to have stood the tests of the depression.

A Summary of Personnel Practices, 1929–1936

Total Companies Surveyed.....64 Total Employees Affected.....309,317

	Percentage of Companies Using			Per Cent of Employees Affected
	1929	Dropped 1929-36	1936	
Personnel Records				
Job Analysis	39.9	2.4	48.4	55
Time and Motion Study	50.8	1.2	55.7	80
Qualification Card	30.3	....	35.1	41
Promotion Chart	8.5	1.2	12.1	17
Personnel Control Chart	9.7	....	13.3	21
Rating Scale	35.1	1.2	44.8	50
Progress Chart	7.3	1.2	9.7	18
Selection and Placement				
Application Blanks	79.9	....	89.5	100
Interviews	84.7	....	89.5	97
Questionnaire	25.4	....	31.5	46
Tests for Hiring	35.1	1.2	37.5	72
Tests for Placement	20.6	1.2	21.8	36
Personal Introduction to Job	65.3	....	84.7	91
Follow-Up of New Employee	26.6	1.2	35.1	33
Periodic Interview	31.5	1.2	43.8	44
Training				
Sponsor System	4.8	....	9.7	9
Company Training School	26.6	4.8	29.1	49
Job Instruction	65.3	1.2	72.6	96
Foremanship Training	41.1	3.6	42.3	67
College Co-op. Programs	25.4	4.8	31.5	67
Benefit Plans				
Group Insurance	60.5	....	75.0	91
State Insurance	23.0	....	32.7	27
Pensions	37.5	4.8	36.3	60
Accident Insurance	56.9	....	65.3	81

	Percentage of Companies Using			Per Cent of Employees Affected
	1929	Dropped 1929-36	1936	
Personal Relations				
Housing	20.6	1.2	21.8	35
Athletic Teams	65.3	6.1	71.4	74
Dances	38.7	3.6	44.8	58
Clubs	37.5	2.4	44.8	77
Plant Paper	37.5	8.5	37.5	68
Cafeteria	58.1	3.6	60.5	78
Reading Rooms	30.3	1.2	32.7	60
Health Insurance	54.5	....	62.9	87
Company Hospital	42.3	....	43.5	52
First Aid Stations	61.7	....	71.4	88
Visiting Nurse	36.3	2.4	37.5	50
Financial Aid	52.0	1.2	61.7	74
Legal Aid	39.9	....	46.0	65
Employer-Employee Relationships				
Industrial Relations Council	13.3	1.2	19.4	44
Employee Representation	24.2	2.4	38.7	64
Interview for Grievances	47.2	....	66.5	64
National Unions	1.2	....	9.7	12
Local Unions	4.8	....	9.7	8
Company Unions	13.3	1.2	16.9	14
Profit Sharing	13.3	....	14.4	22
Stock Purchase Plan	23.0	15.5	12.1	12
Representation on Board of Directors	4.8	1.2	6.1	3
Suggestion System	46.0	3.6	53.2	69
Personnel Research	23.0	....	31.5	53

Flexibility was the keynote when the Chicago Electric Manufacturing Company's new plant was designed. Of one-story brick construction, 500 by 160 ft., it has an individual freight siding and two truck loading docks. It is the type of factory building that can be economically adapted to the needs of next year—and the year after

Build Today's Plant for Tomorrow Too

F. C. FOLTZ
Architect, Clearing Industrial District
Chicago

You'll have to use next year the new plant you're building this—you or somebody else. So when you build, be sure you build an "extensible" plant—one that can be readily expanded or just as easily subdivided

ONE OLD saying certainly is valid as it applies to a manufacturing business: "Nothing ever stands still; it either goes forward or loses ground." Especially is this true in industry. From my own contact with several hundred factory planning or building jobs, I have encountered just one business that violates this rule. It happens to be a specialty manufacturing business, highly profitable. The owners prefer not to get involved in too big a job either of work or of financial commitment. So when they built a plant they said, "Here's what we need. Don't bother to provide for expansion. We're not going to expand. We can sell the capacity of this plant, and don't want to sell any more."

Every other manufacturer with whose building project I have been connected has planned on a larger and more profitable business. Not all have succeeded in their ambitions, but the ambitions have been present. Our one exception merely proves the universality of the rule.

Yet whenever a man with experience in factory building looks over the ordinary assortment of plants that come under his eye, such as may be seen on any railroad trip, he must be struck by the obvious lack of foresight and proper planning. Even so casual an inspection is sufficient to bring to his attention literally dozens of makeshift plant buildings, which may conceivably fit the particular task of the instant, but which have utterly no value when and if there comes a need for expansion.

Nor are these makeshift additions the only building misfits to be observed. There are the innumerable buildings that stand empty with broken or boarded windows—monuments to the faulty planning of some earlier manufacturer. And there are the buildings that, despite a process naturally fitted to single-story production, have had to go up in the air—at increased cost for handling materials—because additional land was not provided in the earlier stages.

Future Is Never Certain

What all of this is getting at is that each job of industrial building, whether a brand-new plant or an addition, should be planned and erected with the knowledge that nothing in the future is ever certain. If the business succeeds, then expansion will be necessary, and the plant would be built to provide for expansion. If the business fails or does so poorly that the owners should decide to retire from the field, they will be just so much better off if their factory is built along lines that make it easily salable to the largest possible variety of other manufacturers, or if it is so laid out that it can be economically rented.

If, perchance, it should develop that they will be better off at some distant future time by getting rid of part of their business and continuing another part, a plant that is simply divisible and provided with the essential service facilities in the right locations will be a money-making asset instead of a tax-eating liability.

In the course of building a great many factories over a long term of years, we have learned a great many simple tricks which might better be public property than private ideas. The purpose of this article is to pass along the most widely applicable of these ideas for whatever good they may do. Necessarily we shall be concerned principally with ideas that apply to the largest number of lines, and shall side-step highly specialized problems. But, from an experience with a far larger variety of manu-

facturing than is the lot of most people who will read this, let me urge that no manufacturer think of his own building requirements as highly specialized. The chances are that you can do your actual manufacturing in a building that will just as well fit the production job of practically any other business requiring approximately the same floor area.

If you incline to doubt this—most people do, when first we talk with them—and think that a plant has to be designed so that it will fit one industry and no other, let me first admit that it might be difficult to convert a rolling mill into a typewriter factory. Some few industries, mostly requiring huge plants, profit best by erecting buildings that are specialized tools of their trade.

During the depression we lost from among the firms in our district a normal proportion through failures, mergers, and other results of economic distress. Most of these companies have been replaced by tenants who are just as well satisfied, and able to operate therein just as efficiently, as the firms for which the buildings were designed. A radio plant now houses a surgical supply factory—so well that the new owners have just built a large addition. A stove maker's building is now used for making corrugated boxes. A maker of waxed paper is doing well in an automobile plant. A steel window factory is turning out sausage casings. The list could be extended indefinitely.

One-Story Plant Our Choice

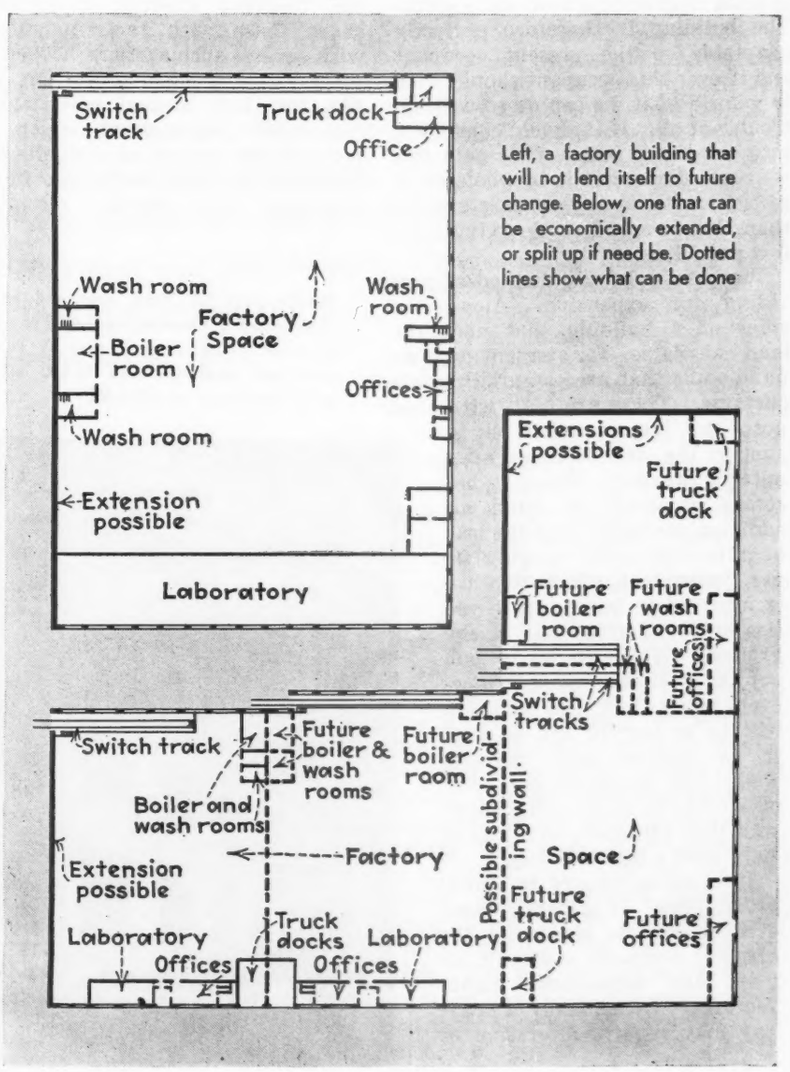
What are the specifications that make a building so readily convertible? First let me disclaim that we have the only workable formula. Our situation being as it is, we prefer a certain type of building. Under other circumstances other types might fit admirably, but we have almost unlimited land available at reasonable cost, so we are committed to the single-story plant unless there is some special reason for multi-story. The single-story structure gives unlimited floor load, eliminates lifting and elevating inherent in multi-story construction, and permits easy expansion in any direction where land has been provided, thus leading to a minimum of internal adjustment to fit the plant into the added space. In our minds it is unquestionable that the single-story plant is most easily adaptable to use in a variety of industries, which is a major reason why we prefer it.

Even a single-story plant, however, unless it is so small that it would not conceivably ever require dividing, can be so built that it is not too easily adaptable. I know one vacant plant in the neighborhood of 100,000 sq.ft. that is a perfect example of how not to do it. The building is single-story, almost square. It is served by a switch-track along the rear, with the loading dock at the corner so that it is accessible also to trucks from the side driveway. This is the principal flaw. If that plant had any possibilities of dividing into two or three parts, it would have been sold or leased long ago. But the track and loading dock situation means that it can fit only a single occupant—and there are probably twenty manufacturers requiring 30,000 sq.ft. to one who can profitably use 100,000.

Consider another plant of about the same size which we built a few years ago. It is L-shaped, but has even more irregularity about it because the long side of the building has an additional 16-ft. offset. The switch-track comes in along this long side, with one spur running into the section that is the short part of the L, with one spur running in through the end of the offset, and one at the end of the long section. The three spurs are parallel, and close enough to afford every advantage.

Six Ways to Subdivide

There are half a dozen ways in which we can subdivide this building. In laying it out we convinced the purchaser that his offices should run along the short end of the building, and come on around the corner a short distance. His experimental laboratories are situated about halfway down the long side, which makes them accessible to the manufacturing departments. If ever the building is split up it is possible to provide office space in almost any conceivable combination, and with no major alterations. Washrooms, for



Left, a factory building that will not lend itself to future change. Below, one that can be economically extended, or split up if need be. Dotted lines show what can be done

instance, are set in the interior in two banks. As used at present, each bank is divided into part for men, part for women; in any future subdividing, partitions can allot these halves to different tenants, requiring only one small partition in each case for further subdivision.

Again, the truck loading docks were built one at the far corner, the other part way down the long side. In any ordinary dividing, three tenants could be provided with adequate facilities, and there is another point where a dock could be set in at reasonable cost.

Three Ways to Grow

Now for expansion provisions. The shape of the building permits adding in three directions, which means that as the present occupant's business grows he can add new space where most needed. Likewise, if ever there are several manufacturers in this same building, there will be an opportunity for each one to build if he should need more space. The building is therefore perfectly adaptable to the present occupant and if ever this occupant should wish to get rid of it, he can do so with no trouble at all. If it should come back into our hands before it is paid for, we could dispose of it in whole or in sections without any expense greater than that involved in throwing up a few partitions.

We have a definite method of providing for expansion. Along the sides of a building that abut the land available for expansion, we build walls that are essentially glass curtains. These are built with steel posts and just enough brick to support the steel sash and keep out the weather. When it becomes necessary to build an addition, we figure that the loss of this wall costs roughly $4 per linear foot, which expense is incurred in labor and in the loss of foundations left in the ground. What we do is pull out the steel sash, move it however many feet the addition will be in length, and re-erect it as another such movable wall. Try to figure out some other way to get a satisfactory wall that will cost you a loss of only $400 a hundred feet.

It is not necessary to standardize bays. In general, whatever reasonable size suits the original occupant will suit almost any subsequent manufacturer. Occasionally a crane bay may require alteration or strengthening to accommodate some other manufacturer's needs but even here it is surprising how often the new occupant finds it more economical to get along with the existing facilities than to rebuild.

Economies of Partnership

Certain other service facilities require consideration against the possible future use of the building by more or different tenants. We have found it unwise to try to split up the heating and process steam boilers —practically all plants in our district purchase central station power. In several instances it has been very easy to work out some cooperative arrangement for sharing these facilities, and where one industry requires an unusual volume of steam, the cost can be equitably divided by the use of steam meters.

Similarly with fire pumps and sprinkler system tanks. The economies of partnership in this field are so great that manufacturers in the Clearing District customarily share these with their neighbors, with several such systems hooked together into a super-protection system for their mutual advantage.

Another requirement which experience has proved advisable is that buildings be made attractive in appearance, not merely structural shells to house manufacturing operations. The cost is negligible. For example, one of the most attractive plants in our district cost $7,000 over what it would have cost without any dressing up—on a total cost in the neighborhood of $350,000. A one-acre plant, we figure, can be made good-looking at an increased cost of not more than $2,500. The advantage to the business is sufficient, if only from the standpoint of advertising, to justify the added cost. And if at any future time it becomes necessary to sell or lease, this appearance factor will repay its cost many times over.

Beauty pays for itself over and over again when it becomes necessary to sell or lease. The original cost is comparatively small—perhaps $2,500 extra on a total cost of $100,000

Painting with Profit

We have learned through hard experience that it pays us to repaint a building inside and out after it is vacated and before we even try to find another occupant. The prospect on seeing a dirty structure is repelled by its condition; if he is still interested, he thinks he should get it at rock-bottom price. Since this is so important in relation to a job of surface painting, it is easy to establish that an attractive exterior is as good a selling point in the event of future need. Incidentally, next time you are looking out a Pullman window at the deserted plants, notice that those which show evidence of long vacancy are inherently unattractive. It is not so much that vacancy has rendered these buildings rundown, as that unattractive design has practically assured that they remain vacant.

The basic rule to follow in planning a new building or an addition is to ask yourself: "What will happen to this building at some time in the future? Is it planned to yield us the maximum return not only as a tool of our own manufacturing, but also if we have to expand, shrink, move, or subdivide our operations?" If the answer to this latter question is an unqualified "Yes!", then your building is the sort that I am advocating. If your plant is built to the observance of the general principles laid down here, you may rest sure that your investment in bricks and mortar, instead of being something to which your grandchildren will regretfully point as a monument to bad planning, will be quickly realizable either in a sale or lease that will make it profitable investment in the hands of a good tenant.

Fifteen Months More of Paying by the Year

ARTHUR VAN VLISSINGEN, JR.
Consulting Editor

Of unusual interest because it recognizes that workers live by the year, the Hormel straight-time plan passes another milepost in its successful progress. Factory published full details of the plan a year ago last August, takes this opportunity to bring the record up to date

EMPLOYERS who wish to devise means by which they may pay their workers in a way that will permit them to live by the year and plan their household budgets in workable fashion, have been watching with a great deal of interest the straight-time plan put into effect by George A. Hormel and Company of Austin, Minn., about three years ago. The plan and the first year's experience under it have been previously* described in this magazine. Now, with the added experience of another fifteen months and with a much wider extension of the plan in the Hormel plant, comes the opportunity to see just how this unusual method of compensation is working out.

Essentially the straight-time plan is as follows: A unit budget of production is set, based on the normal volume and the most accurate available forecasts of sales and of livestock supply. For example, in hog killing and hog cutting the quota is 1,000,000 hogs a year. In a sausage department, the production budget for 1936 was 5,000,000 pounds of sausage. And so on, with production budgets set by whatever unit applies. The standard gang or labor force required by experience in the plant constitutes the labor budget for this scheduled production.

This production personnel is figured into dollars by multiplying the normal working hours of each worker by his regular hourly rate of pay. The total constitutes the number of wage dollars required to operate the department for the year at the budgeted rate of production. The company agrees to pay this number of dollars in 52 equal weekly installments, and to maintain this rate.

It is obvious that this plan keeps the men working steadily week after week, and stabilizes the production force at just about the same number of men throughout the year.

From the standpoint of the workmen, there is the great advantage of having an even weekly income, no matter what the hours worked. Also, there is the assurance of the full year's employment. Likewise, by absorbing inequalities of production within the gang, they get more dollars per year than if there were outsiders coming in to share the aggregate payroll of the heavier seasons. And there is always the chance of getting extra compensation at the end of the year for exceeding budgeted production.

In the past fifteen months, one large gang has elected to shift back from straight time to hourly wages. This is the sheep killing gang. One small gang, beef rendering, has done the same. At the same time, four gangs have shifted from hourly wages to straight time — machine shop, pipe shop, electricians, building maintenance. And the sweet pickle gang of 106 men is right now negotiating with the management to go on straight time.

Let us look at the reasons for these shifts. The sheep gang is emulating the beef gang, which has always remained on hourly wages. It happens that the Hormel plant's supply of cattle runs evenly, week after week, throughout the year. The hog supply has sharp peaks and valleys. The sheep supply falls somewhere between the two, with less assurance of steady supply than the beef gang and without the layoff periods that are an important part of the hog department's operating problem.

The sheep gang was none too thoroughly sold on straight time when its members elected to adopt it. The gang includes, just as does any factory department, a certain proportion of workers who would rather know that they will come to the plant, do a day's work, and collect a day's wages — with nothing more to think about or figure out. The way the sheep supply has been running, hourly wages look better to the sheep gang than straight time. The management's guess is that when the sheep supply falters, this gang will see that it would have been better off on straight time, that the overtime that has come to the gang on occasion during this season (it earned and received a bonus on 1935 production) will be more than overcome by the short pays when the sheep supply again falls off, as inevitably it will.

Preferred Longer Hours

The beef rendering department is a small unit, and its volume of work is chiefly dependent upon the beef kill — therefore to this extent its volume is steady. During the past year the beef kill gang, on hourly wages, has worked certain weeks of 48 hours. The beef rendering gang has been getting 40 hours' pay on the straight-time plan. There looked to be an opportunity here for the rendering gang to work somewhat longer hours than 40, and thus at the hourly rate to draw more pay per week. For this they were willing to trade off their assured year's work and their 52 even pay days and shift back to hourly wages. It is a perti-

* "Paid by the Year," p. 323, August, 1935.

nent indication of which workers prefer, short hours or longer hours with more money!

In the beef kill gang the volume of work is so steady that there would be little advantage to the men in going on straight time — and they now get any overtime pay in the week's check, instead of waiting for the year's output to be figured and their bonuses computed therefrom. Also, beef butchers are the aristocracy of the plant in any meat packing establishment. They are chiefly old-timers who are set in their ways. As a consequence, they tend to be the conservatives in all innovations.

Much the Same Thing

They have, however, adopted some features of the straight-time plan so that in most respects they are on essentially the same thing. The plant departments all take 10-minute recesses at mid-morning and mid-afternoon. The beef gang's normal production is 85 cattle an hour. They can, if they wish, work faster. So each day they make up enough extra cattle to "pay for" the two recesses. For this, they receive 40 hours of paid vacation per year, like those departments that are on straight time.

In view of the rather level flow of cattle, this department is therefore working out very much as though it were on straight time. The only important differences are that the men do not have the guaranty of full-time work throughout the year, and also that they get short pay checks for the weeks containing holidays.

As is suggested in the paragraph above, part of the straight-time agreement is that these workers get six holidays a year (although they may work full number of hours in a holiday week) also vacation for another six working days. This is how the four mechanical gangs happened to go on straight time. They came to the management asking vacations. Their representatives sat down to talk it over, agreed that the only practicable way to accomplish this was to have the men absorb the extra work during vacation periods on practically the same basis as office departments.

This situation was made-to-order for straight time. The gangs had previously had regular employment. Their work is difficult to supervise because it is scattered throughout the plant. Since straight time afforded the way to give the men the vacations they wanted, they asked to be put on straight time, and got it. It was in no sense of the word a mere case of trading vacations for a pet scheme of the management's.

The sweet pickle gang, 106 men, has asked for straight time, and this is now in process of negotiation. In this, as in most other departments where the men are scattered about in one's and two's and three's, supervision is difficult. The foreman knows about how long a given job should take, but he cannot prove it, and there is no way to check up. The men have been averaging better than 42 hours a week; they are asking 42 hours' pay for 40 hours' work. They, and the management likewise, know that they can do their work in 40 hours without hustling. But there is the difficulty of putting this gang on 42 hours' pay as straight time. alongside other departments that have only 40 hours' pay under straight time. Doubtless this will be worked out to everybody's satisfaction, but at the moment it is at a standstill. Eventually, the chances are 10 to 1 that sweet pickle will go on straight time.

More on Straight Time Today

A slightly smaller proportion, though a materially larger number, of the entire plant force is today on straight time than was working under this plan fifteen months ago. It has happened because additions to payroll have been chiefly in other than straight-time departments. In the spring of 1935 there were 1,436 out of about 2,400 employees on straight time, almost exactly 60 per cent. Today there are 1,592 out of about 2,849 or 55.8 per cent.

This change has come about entirely of the workers' volition, and at their request. The management is not trying to force it in any way. A fair guess is that the proportion on straight time will increase each year for some years. The increase in number of employees has come primarily because of increase in volume of specialty products. It is likewise noteworthy that while there has been an increase of production in the straight-time departments, they have shown little increase in personnel. The increased personnel has come chiefly in the departments that remain on hourly rates.

Bonus for Some

One department, sheep kill, last year received a bonus because of going over its production budget; the overage was paid at the end of the year on hourly rates. This year in one sausage department the volume has greatly exceeded the production budget. It was set at 5,000,000 pounds for 1936; as this is written, it looks as though it will reach 7,000,000. The increase has come because of increased sales, and has been made possible in large measure by the extra efforts of the workers, in perhaps equal measure by installation of better machinery and added care in supplying materials that are easier to work.

When it became apparent that this sausage department would thus greatly exceed its production budget, the workers' representatives requested that for the remainder of the year each worker receive two pay checks,

(Continued on page 79)

The straight-time wage plan is good for management because it fixes labor costs, decreases layoffs and rehiring; good for the men because it guarantees a steady weekly income and a full year's employment. After a lifetime of not knowing where they will be from one pay day to the next, those on straight time know exactly what they can or cannot do

Your Inventory a Graveyard?

Don't let it become a catch-all where mistakes in design, sales effort, and management planning lie buried. Inventory can be kept alive and in the best of health

GEORGE T. TRUNDLE, JR.
President, The Trundle Engineering Company
Cleveland

AS PRODUCTS become obsolete and unsalable, many concerns adopt the expedient of leaving them in the inventory rather than performing the major operation of writing them off as so much junk or scrap. Others, in a desire to keep the plant operating and employees on the payroll, pile up inventory far beyond reasonable demands. "It's like money in the bank," they say, "and it costs us only 6 per cent."

Among concerns we have surveyed, have been some that were saved from bankruptcy only by liquidating inventories which had been accumulating for years. Others have been able to operate for extended periods, feeding on expensive, disproportional inventories hoarded during more prosperous days.

In one case, a concern making a very large and expensive unit showed a net profit for four years of more than $100,000 annually. The profit was poured into inventory, and the management borrowed to pay its dividends. Liquidation of the inventory brought a handsome bank balance and an ability to pay dividends out of cash and not borrowings.

All of which brings up a question of vital importance to every plant operating official:

"What does it cost to carry an inventory?"

Too frequently the answer is a quick, "Six per cent." As far as we know, and we have studied hundreds of businesses, we have yet to find one case in which this was the correct answer. The truth is that few manufacturers are able to answer accurately, considering all the factors.

They Don't Know the Cost

We became interested recently in finding out how closely the average executive's idea of the cost of inventory carrying approximated actual costs as we had found them. We sent out hundreds of questionnaires and from the replies were convinced that inventory costs are more often than not an unknown figure. Although many executives could tell us the exact cost of selling a unit of product, the cost of hiring and firing a man, or how much advertising expense should be charged against each sale, they found it difficult to put down in black and white how much they were spending to keep a stock of goods on hand.

The returns brought a wide range of costs. Three typical replies are given in the table. In some cases only two or three of the elements listed were taken into consideration, in spite of the fact that each one is a definite factor in arriving at the total of inventory costs. We found that total costs varied from 12 to 35 per cent. Many were too high; an even greater number were too low.

Cost Varies with the Industry

We have tried from time to time to arrive at a fair average of inventory costs, but study has shown that this is impossible to do with any degree of accuracy. Cost varies with the industry. Again, for a perfectly good reason, there may be a considerable difference among companies in the same industry.

Two factors frequently raise inventory costs to an entirely disproportionate total. First, many plants charge items to inventory that never belong there at all. For instance, we made a study of a business some time ago and found the inventory on the books at nearly $1,000,000. This was entirely too high. On investigation we found that all units rejected by customers were, and had been for years, put back into inventory although there was little, if any, chance of future sale. A considerable part of the inventory, therefore, consisted of material that should long since have been scrapped.

Second, relatively few concerns seem to keep an accurate check on what goes into inventory. One con-

(Continued on page 80)

Costs of Carrying Inventories

(per cent per annum)

	Concern A	*Concern B*	*Concern C*
Interest on capital invested	6.00	6.00	6.00
Taxes	2.50	0.55	2.00
Insurance	0.50	0.20	(included above)
Housing	0.50	1.24	0.70
Keeping housing in repair	0.25	(included above)	
Looking after inventory:			
Handling	2.00	3.16	(included above)
Taking inventory	0.25	1.03	(included above)
Clerical costs	1.00	2.58	4.60
Deterioration, spoilage	3.00		
Repairs	1.00		
Obsolescence	5.00	3.43	4.00
Total	22.00	18.19	17.30

Three estimates of the cost of carrying inventories, given by three concerns in reply to a questionnaire. Each is a long, long way from the popular 6 per cent that is so often and so confidently referred to

Revamped Our Shipping Room for Group Bonus

H. B. LEACH
Head of Standards Department
Pro-phy-lac-tic Brush Company
Florence, Mass.

MANY a plant that puts its people on incentive stops short of the shipping room. Often the feeling is that the time and expense involved in setting standards for this kind of work is unwarranted. Few plants, at any rate, have made a real try at measuring the job of packing and shipping.

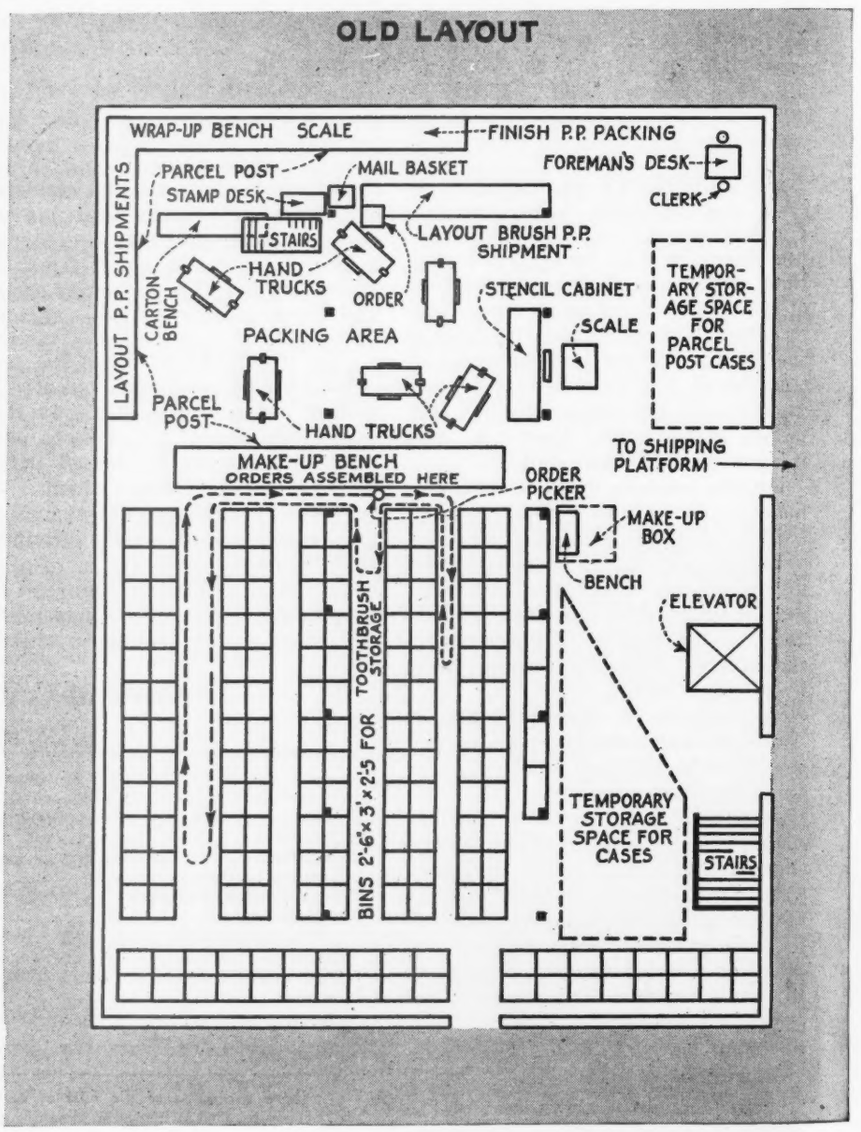
Why any plant management that believes in incentives should give up just outside the shipping room door, is quite incomprehensible to one who has seen a shipping department operate successfully on group bonus these past seven years. And it is indeed in some small hope of dispelling the aura of mystery surrounding this phase of plant operation that this article and its companion piece have been written. In the one I shall describe the changes in the shipping room layout that were made before the bonus was installed. In the other I shall get right down to details in telling how the bonus plan works. So far as I know there is nothing special about the brush industry that need stop anyone from trying to adapt either the layout or the bonus plan to his own plant operation, no matter what the industry. Otherwise there would be no particular point in my writing this article.

What We Had

First I shall have to take you back into the old shipping room and show you exactly what we had. As shipping rooms go, I doubt if it was so very, very bad. However, we knew it could be a lot better, and naturally it had to be as good as we could make it before we could conscientiously put the men on bonus.

At this point, therefore, I refer you to Figure 1, which shows the old layout. All finished stock came into the room via the elevator at the top of the figure. The long rows of squares are bins, some two, some three high. A make-up bench ran along one end of the rows of bins. Here the layout man assembled the goods for each order, and to do so he had to travel up and down the aisles, often finding it necessary to climb to the upper compartments to get the carton of toothbrushes he needed to make up his order. It was entirely possible for him to walk anywhere from two to three hundred feet while putting up a typical order. The dotted line is my conservative conception of where he had to go and how far he had to walk when he put up an order with, say, ten or twelve items on it.

So much for orders. Now for the packing cases to put the orders in. The storage bins took up so much room that there was no space left on the floor for such important



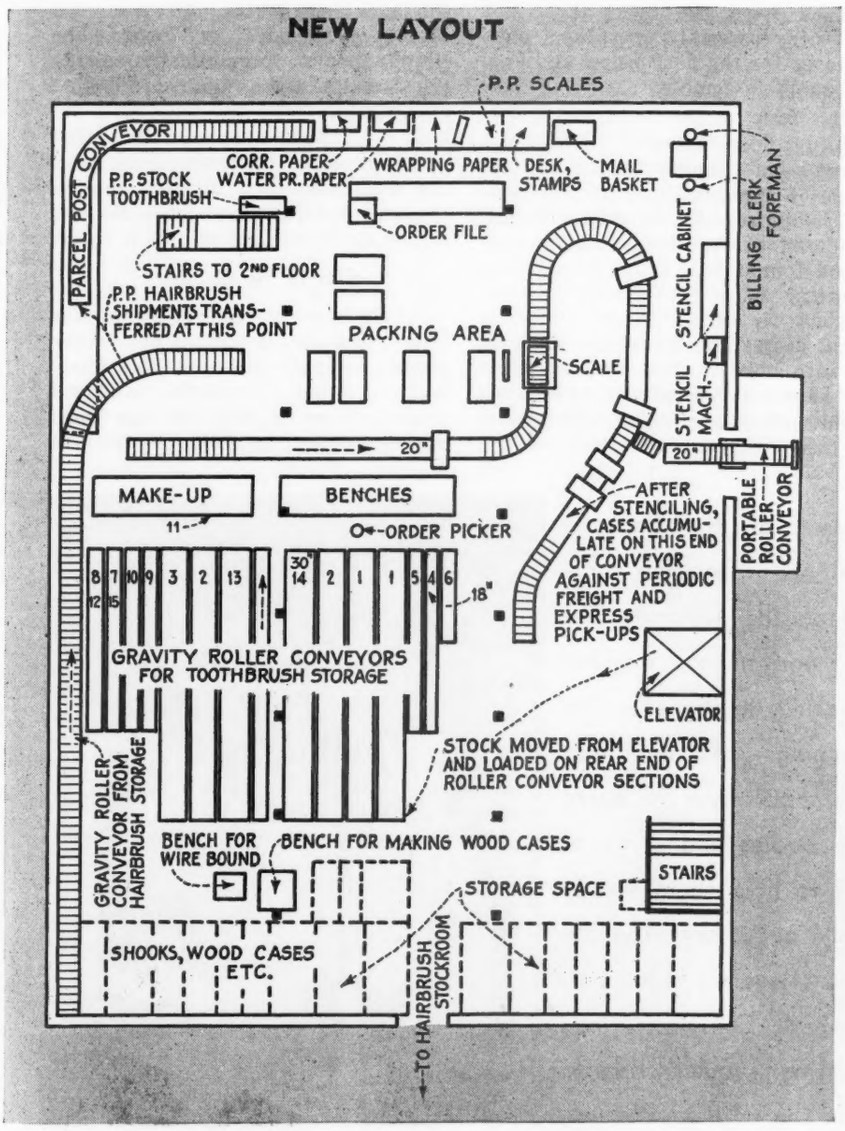
shipping materials as corrugated cartons, shooks, and wire-bound cases. They all had to be kept, therefore, in the basement and were hand trucked via the elevator as needed. Thus loads had to be moved to the elevator from storage, from the elevator to the packing area, and finally—after the cases were packed—moved again to the scales, and over into the temporary storage spaces to be held against the periodic freight and express pick-ups. Some of the loaded cases weighed up to 400 pounds, a good husky load for a two-wheeled truck.

Too Much Heavy Hauling

Several things, obviously, had to be corrected. There was too much walking. There were too many handlings. There was altogether too much heavy hauling.

The first move, therefore, was to knock out all the wooden bins and store the toothbrushes on a series of inclined roller conveyor sections. Stock still comes down from production departments by way of the same elevator, but now it is piled on wooden pallets with heavy cardboard spacers to insure even piling and to keep the boxes of toothbrushes from toppling over. The pallets are stored on the back ends of the gravity roller sections and are moved down to the front where the layout man operates.

Toothbrush stock is carried on roller conveyor sections at left of photograph. Orders are assembled with minimum of travel on benches, then packed directly on roller conveyor that runs down the center. In background, under windows, gravity roller conveyor from the adjoining hairbrush stockroom



Now, if you are looking at Figure 2, you will see that his roadwork has been cut down to the bare minimum. The more popular types of toothbrushes are kept on the roller sections immediately at his back, so for a large part of his order he has merely to turn around in his tracks. The longest trip he ever has to make is down to the end of the tier of conveyor sections. There is no longer any running up and down the aisles, and never any climbing. Figure for yourself the time that has been saved. That, of course, is the main benefit, but another big advantage is that by this method the oldest stock always moves out first, not so important perhaps with toothbrushes as with goods of a more perishable nature, but important enough.

Saved Floor Space

I said the saving of the layout man's time was the chief benefit, but should have put on a par with it the saving in floor space that was made possible. So much floor room has in fact been saved that it is no longer necessary to store shooks and other packing materials in the basement. Now all these things are stored in the back of the room, and cases are made up as needed and moved down one of the roller sections to the packing area.

Unfortunately there is no room left over for the storage of other types of brushes—hairbrushes, nailbrushes, and the like, which we are making each year in ever-increasing quantities. These other brushes are

(Continued on page 84)

Work at Work Level

G. T. CHRISTOPHER
Vice-President in Charge of Manufacturing
Packard Motor Car Company

PRODUCTION men universally accept the principle that work should be brought to the work level. But they accept it with the realistic reservation that in many instances it cannot be accomplished at sufficiently low expense to make it feasible.

The method by which work-level work is attained in the body shop of the Packard One Twenty plant overcomes many of the difficulties which have prevented it in other plants. The crux of our method is that it makes practical a change in work level along an assembly line, just as often as desirable, and at practically no increase in operating and maintenance costs.

Wide Applicability

Of course the details of our body shop installation may not fit many other lines of industry, but the basic method should have wide applicability. Because an understanding of this installation should help factory executives to see the opportunity for similar set-ups and to work out their own applications, it is told here in some detail.

The installation in question is found practically throughout the sheet-metal body-building shop where parts coming from the presses are joined in huge special-purpose welders which weld together whole rear body sections. It carries the sub-assemblies until they are finally put together into a body, then carries the body through the painting and finishing operations.

When the body has reached this point, it is ready to move to the floor below, where the assembly line takes the painted shell and fits it with windows, cushions, instruments, wiring, and the manifold items that go to make it ready for mounting on the chassis on the ground floor.

It is not necessary to follow the body all the way from sheet-metal parts to final assembly in order to understand the method we are discussing. We can obtain a thorough grasp of the situation by going with it merely along the body assembly line, from the time it is lowered from the floor above for final body assembly operations until it leaves for the floor below and final automobile assembly.

The body comes from the body-building floor, lowered by a hoist through an opening in the ceiling. When it appears through the opening, it is already cradled in a fixture composed of two basic parts. One is the foundation, which is a frame identical with the frame of the finished car except for a few additional projections to permit hooking on with hoists. The other part of the fixture is essentially two yokes at the ends of the frame, which come up over at front and back of the body, and are joined by a fore-and-aft rail over the body.

It is this fixture that the hoist lowers to the body floor. Beneath the hoist an ordinary floor dolly has been stationed, large enough to handle the body. The hoist is now unhooked, a man pushes the loaded dolly away, an empty fixture on a dolly is pushed beneath the opening, hooked on, and hoisted to the floor above to replace the fixture that has just been lowered. This fixture is known in the body shop as a "buck."

The dolly, bearing the buck containing a body, is pushed by hand some 15 ft. to the beginning of the body line. The dolly is pushed in the proper direction until it comes up against a projecting floor stop which serves as an automatic guide to place it in line with the assembly conveyor. The motion of the assembly line comes from an overhead chain. The chain carries hooks, and the buck has on its top member a couple of shackles or loops. The chain's hooks automatically engage the shackles, and as the chain begins rising right here, the buck with its body is lifted clear of the dolly, which remains upon the floor until the man who does all this miscellaneous pushing around at this end of the conveyor line moves it aside.

Out of the Ordinary

At the start of the line it appears to be merely an ingenious but rather ordinary application of the time-honored application of the overhead chain. After the 6-in. lift has freed the buck from the dolly, the body in

Secret of the Packard method of keeping bodies on the assembly line at convenient working level lies in the effective teaming of overhead chain conveyor to carry the bodies and a monorail to hold them steady while necessary assembly operations are being performed. On interior jobs workmen regularly ride inside the body

the buck moves about 60 ft. around a curve, straightens out onto the floor-long straightaway. And now we see why the method employed is so good.

Essential equipment is the overhead conveying chain and a monorail track underneath the work. The buck has on the bottom a couple of guide-irons, visible in the photographs, which catch on both sides of the monorail track. It has always been a recognized and characteristic advantage of overhead chain conveyors that they can be run uphill or downhill at little or no additional expense over operation on the level. Chief disadvantage, for many assembly operations, has been that the work naturally swings sidewise from overhead suspension and is not rigid; hence cannot be easily worked upon.

The Secret

Addition of the monorail beneath the work is the secret of the Packard operation. The overhead chain conveyor performs its time-honored function of varying the height of the work to bring it to the most convenient and economical working level for each operation. The supporting monorail supplies the requisite rigidity. And it is a simple matter to vary the levels of overhead chain and supporting monorail—just so the distance between them remains constant—and thus raise or lower the work without for an instant losing the requisite rigidity for best working conditions.

Nor is it essential to have the monorail at stations where rigidity is not needed. For example, it would be impossible to run the buck around a sharp curve on the monorail because it would bind on the rail, though it goes easily enough by chain. So at the curves the monorail is not present, and the work performed along the curves is of the sort where a little free swinging is of no detriment. At various other sections of the assembly line, for one reason or another, the monorail is dispensed with. Wherever rigidity is a consideration, it is present.

About 60 ft. down the first straightaway, work begins on the top of the body. Here is a beautiful example of the flexibility of this installation. Formerly, workmen doing operations on the outside top had to stand on rather high platforms, which carried a danger of serious falls, plus the loss of time and energy involved in frequently clambering up and down. Now the monorail is fastened flat to the floor, the overhead chain dips down accordingly, lowering the work as far as possible.

A platform elevated 6 in. above the floor, about 2 ft. wide, runs alongside the line here. The workmen stand on this little elevation and comfortably handle the work. Incidentally, this is the only point on the entire line where workmen cannot stand on the floor for exterior work. On interior jobs requiring it, workmen regularly ride inside the body, even taking in with them cushions or seats or whatever is necessary for comfortable working. Where the platform ceases because top work has been completed, perhaps 150 ft. farther along the line, the chain and monorail both rise a little, making it easier to work on the sides of the body.

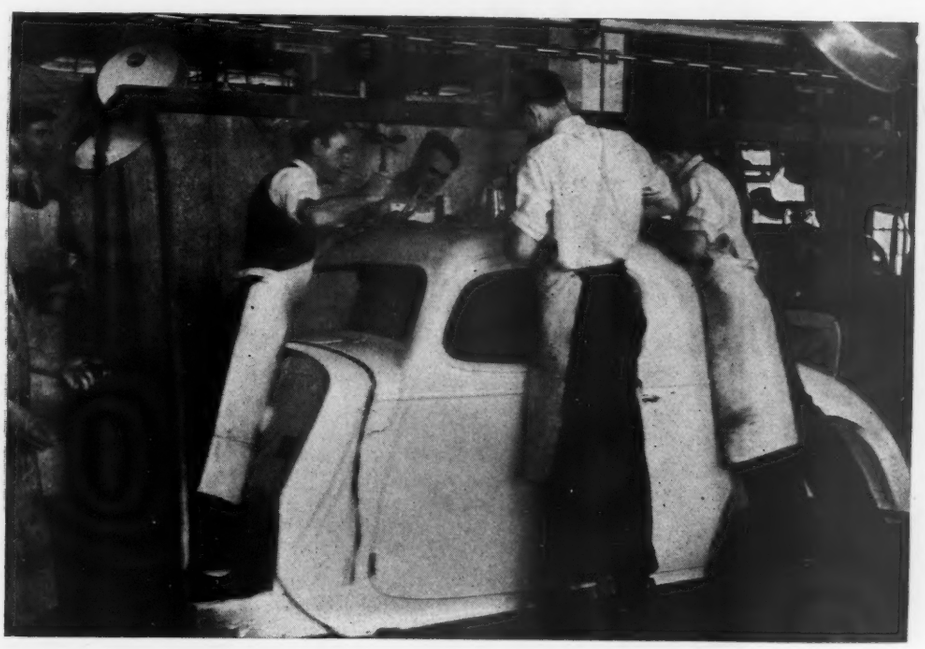
At various points where bulky parts or sub-assemblies are needed for the body, they are brought by overhead supply chains that feed the big line. The overhead chain may carry a miscellaneous assortment of window frames, window glasses, and what not. Most of the way it runs along at a considerable height, out of the way of everybody and everything. Where the big line needs a part, the feeder chain dips down to a level convenient for the removal of its piece, then rises again and gets out of the way.

Complete Flexibility

The body line runs up and down the length of the floor to accommodate the many operations required. At the end of the line, when the job is finished, the body must be lowered to the floor below, and the location of this floor opening is governed not by body-line convenience but by the requirements of the finished-car assembly line below. It happens to come at a point that would normally be intersected by a couple of lengths of the body line. But with their great flexibility, they just curve around here with no interference.

From time to time along the line the supporting monorail is not used. One of these stretches is at a point where wiring is done. There was, in the early days of the line, some occasional difficulty through getting wires tangled in the rail and the

(Continued on page 84)



Body comes down, men go up to perform operations on the roof. At this point the overhead chain has taken a dip to bring the work as close to the floor as possible, the monorail that steadies the body is right on the floor, the men stand on a low platform. There is no danger of serious falls, no time and energy lost in climbing up and down

Teach It with Pictures

Ordinary instruction sheets used in teaching the "one best" way require lengthy, often tiresome, descriptions of the job that is to be learned. A better plan is to take "still" photographs of the more important elements and use them in place of a lot of words

A. WILLIAMS, JR.
Department of Business & Engineering Administration, Massachusetts Institute of Technology

FOLLOWING the development of a "one best way" to do any specific task, either as an improved method over some older method, or in setting up a new process, industry is confronted with two problems. The first is that of installing the "one best way"; the second involves its maintenance until such time as the work is dropped or a better method of doing the job is discovered.

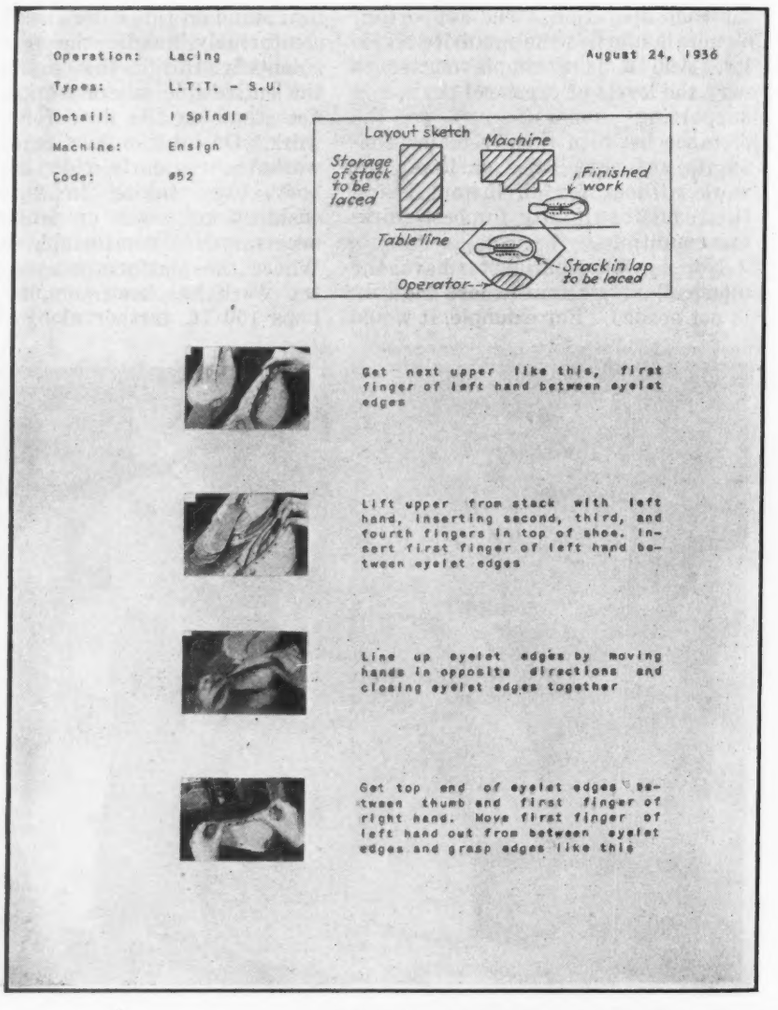
These two problems are solved in a large footwear plant by a carefully developed training program and the establishment of suitable standard practice records which designate the method of doing factory operations and which may be used for reference. These written operation analyses describe the method of doing the job with sufficient detail so that supervisors and instructors can use them as guides in learning the method themselves and for teaching learners.

In describing even a relatively simple operation, a considerable amount of detail is frequently necessary to insure that another person may accurately reproduce the desired motions involved. The purpose of such an analysis is to convey a mental picture to the reader, and the thought is naturally suggested that this can be more easily accomplished by visual methods rather than by reducing it to a written explanation that has to be translated into a mental picture, which is necessarily incomplete.

Educational Movies

Motion pictures have been extensively used for educational purposes and have a wide application in the industrial field. Movie loops have been successfully used for some time in supervisory training programs and have been described in a number of articles that have appeared from time to time in *Factory*.

These efforts have led to the conclusion that the motion picture may become a valuable aid to the in-


Operation: Lacing
August 24, 1936
Type: L.T.T. - S.U.
Detail: 1 Spindle
Machine: Ensign
Code: #52
Layout sketch
Machine
Storage of stock to be laced
Finished work
Table line
Stack in lap to be laced
Operator
Get next upper like this, first finger of left hand between eyelet edges
Lift upper from stack with left hand, inserting second, third, and fourth fingers in top of shoe. Insert first finger of left hand between eyelet edges
Line up eyelet edges by moving hands in opposite directions and closing eyelet edges together
Get top end of eyelet edges between thumb and first finger of right hand. Move first finger of left hand out from between eyelet edges and grasp edges like this

structor, but cannot possibly replace him. This is largely because the motion picture cannot do the necessary "corrective" work. It does, however, become a valuable aid in supplementing the efforts of the instructor, particularly in the "preventive" field.

The Inherent How

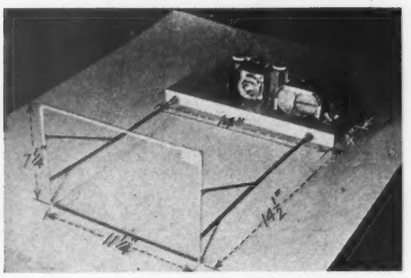
Experience indicates that a considerable portion of the inherent skill or "how" of doing many types of jobs is contained in certain elements or motions of such jobs. These elements are "GRASP," the way in which various objects are picked up by the hands or by some mechanical means; "HOLD," the way in which objects are held while other elements are being performed; "POSITION," the manner in which objects are located with respect to one another; and "PRE-POSITION," the way in which objects may be located before use.

It follows that these elements constitute the real learning points where carefully-supervised instruction and emphasis on the method are necessary. The actual "TRANSPORT" or travel element is less difficult to learn and is more easily taught. Because actual motion is not necessary, still pictures will accomplish the purpose because better subject definition is secured and more advantageous angles may be secured, all at a much lower cost.

Still pictures are taken of the suggested elements and then mounted on instruction sheets. Concise instructions are given with each picture, calling attention to the various details illustrated. The net result is virtually the operator type of process chart with the greater effectiveness that comes from visual presentation.

Any good camera with a nominally fast lens may be used. The one in the illustration is a Standard Kodak Retina *f* 3.5 lens with portrait attachment.

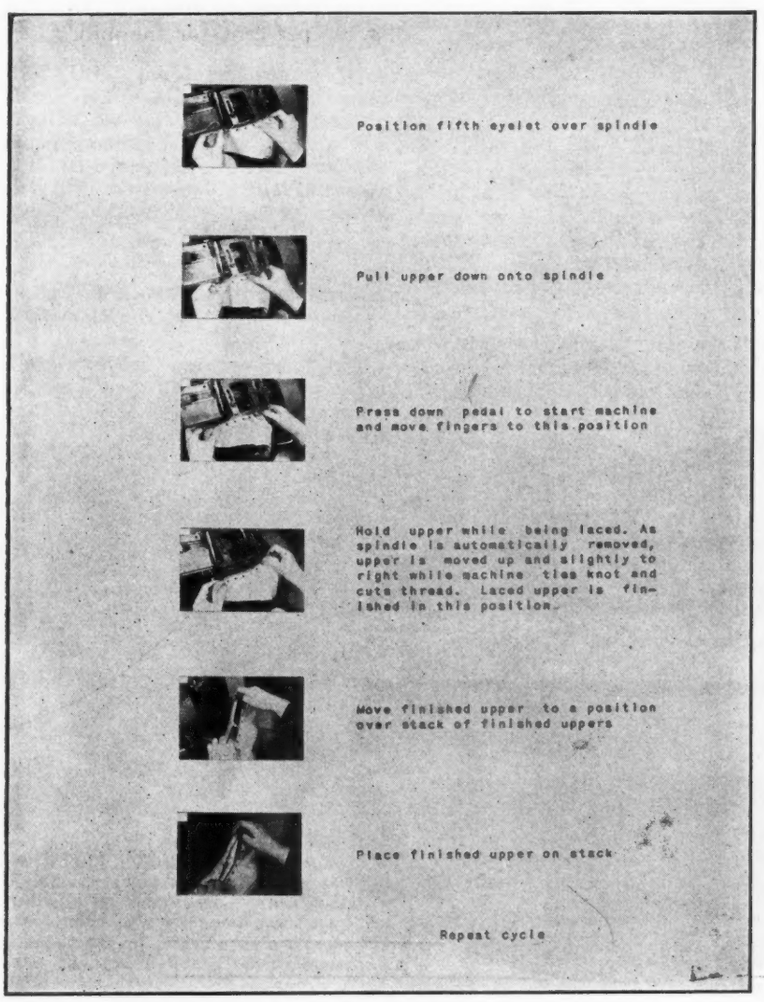
In taking pictures the usual procedure is first to determine the proper "stop" to be used. This may be done by means of a Weston Exposure Meter. After setting the proper stop, the camera is focused on the object, and this is the point where considerable trouble may be experienced. In taking "close-up" pictures at short distances where a portrait attachment is necessary, some difficulty is encountered in framing the subject in the lens, also in accurately locating the camera the proper distance from the object to be photographed.



Here the motion economizer takes a large dose of his own medicine, applies motion study principles to the job of taking still photographs for use in making up instruction sheets. This camera set-up (described in detail in the text) saves time, insures proper "framing" of the subject and correct location of the camera for distance, hence produces better pictures

Applied Motion Economy

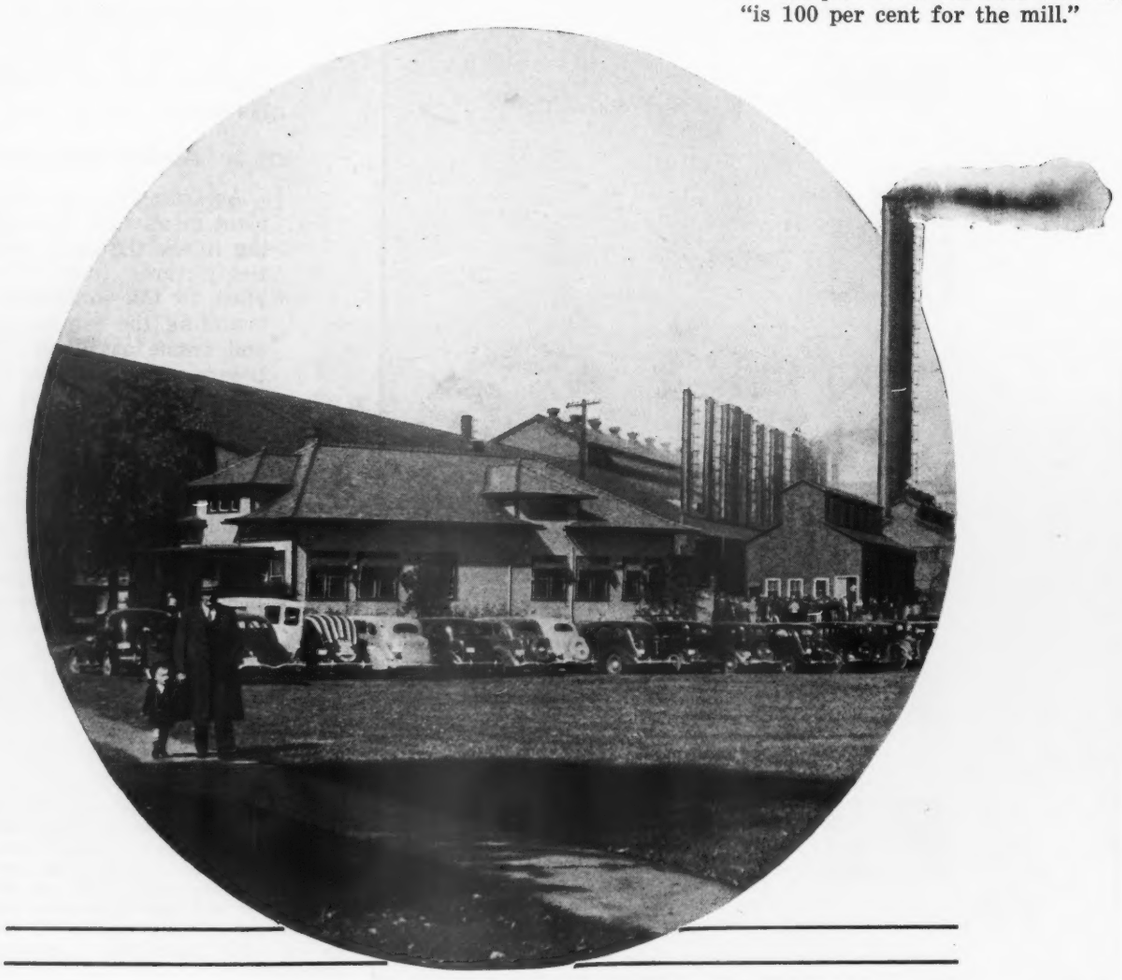
Accordingly, in the footwear plant mentioned, a considerable saving in the time and work of taking the pictures (motion economy applied to the job) was effected by mounting the camera on the board and frame as illustrated. The exposure meter was also mounted, and the diaphragm stops were determined at constant exposures of 1/10 second and placed on a small paper chart pasted on the face of the meter. By using this paper scale, the usual slide-rule work of determining the right stop was eliminated. Two reflectors, each containing two floodlight lamps, served as light sources, and were clamped to the sides of the board. Best results were obtained with openings of *f*9 to *f*14. This unit is also useful in copying work.


Position fifth eyelet over spindle
Pull upper down onto spindle
Press down pedal to start machine and move fingers to this position
Hold upper while being laced. As spindle is automatically removed, upper is moved up and slightly to right while machine ties knot and cuts thread. Laced upper is finished in this position.
Move finished upper to a position over stack of finished uppers
Place finished upper on stack
Repeat cycle

Invaluable to supervisor and learner alike are these instruction sheets developed and used by a prominent footwear manufacturer in teaching the "one best" way. The combination of still photographs and brief instructions has been found infinitely superior to the involved job descriptions commonly attempted

"Where Dad Works"

INDUSTRY has an industrial relations job to do. One of the many phases of that job—and by no means its least important phase—is to sell itself to the community in which it is located. What better way to do this part of the public relations job than to ask people in and show them what goes on inside the four walls where father, brother, or neighbor works? That is exactly what was done at the Guernsey Works of the Carnegie-Illinois Steel Corporation, Cambridge, Ohio. On October 20 an open house invitation was extended to the townspeople through the local management and the employee representatives. Some 10,000 relatives and friends of the company's 900 employees came, saw, went away—with a better understanding of what the mill meant to the community. "Cambridge," to quote a sign that was carried in the parade to the mill that day, "is 100 per cent for the mill."



You want to know

and the editors will gladly tell you more about the things mentioned on this page

• METAL SURFACES can be hardened by electrical induction with a process just introduced. Current induced in the surface heats it up; a water spray built into the inductor block does the quenching. (12601)

• TELEPHONE HOLDER keeps telephone in its place, keeps you from knocking it over or off the desk or table. It's small, can be attached by two screws to wall or side of desk. You can use it at home to protect Junior when he decides he wants to swing on the cord. (12602)

• WROUGHT IRON—its manufacture, characteristics, and applications—is treated in a short book which goes back to the beginnings of forging history to give you the complete picture. Has glossary of terms used in wrought iron manufacture. (12603)

• BECAUSE pushing back a typewriter carriage is an energy-consuming operation, we now have an automatic carriage-return device. Using a fractional-horsepower motor connecting to any convenient outlet, it shoots the carriage back when you press a special key. (12604)

• INJECTION MOLDING of thermoplastic materials is subject of a booklet which also describes one of the important thermoplastics. (12605)

SIGNATURE TIMECLOCK combines printed time records with personal signatures of employees. When lever is depressed day, hour, and minute are recorded on left margin; the employee writes his name beside it, then releases the lever (12619)

• YOU can talk over the lighting circuit with a two-way communicating system designed for interoffice calls. Each unit has four radio tubes and an electro-dynamic loudspeaker to make it go. (12606)

• RUBBER MOUNTINGS for vibration and noise elimination are discussed and illustrated in a manual. Included are deflection curves, safety load limits for rubber, enough engineering data to tell the story. (12607)

• OLD AGE PENSIONS—a booklet on the national old age pension plan for which employees and employers start making contributions on January 1. In it are the questions you've probably had in mind for some time now, and the answers. (12608)

• NON-SPILL utility cabinets hold screws, rivets, nuts, washers, and the thousand and one other little parts that are never where you can find them, and spill when you do get your hands on them. They're built of steel, have drawers swinging out on pivots so that you can get to all corners without pulling the drawer out. (12609)

• WANT a grinding manual showing the latest technique for rapid, economical grinding of carbide tools? (12610)

• PAPER "pie tins," upon which the pie can be baked and shipped to the consumer, have been developed to save handling time and material expense. They're processed with a special lacquer, said to be greaseproof and able to stand 500 deg. F. temperatures. Surely there are many more applications for a material with these qualities. (12611)

• INFLATION—what it is, its different forms, German and French experience with it, and the United States' own past experiments are treated in a booklet prepared by a national economic research organization. Given too is an inflation index to show what the situation is at present. (12612)

• SPONGE RUBBER has been made into small washboards for washing lingerie and other delicate fabrics. We don't suppose you have any lingerie to wash, but this might suggest some use for sponge rubber in your product, or give you an idea for some new use of the product. (12613)

NOT the long-awaited visitor from Mars, but a workman dressed for sandblasting. Facepiece, held on by headgear, filters dust from air fed in through corrugated rubber tube. The detachable, latex-covered silk hood resists impact of flying particles. This mask is expected to go a long way in preventing silicosis (12620)

• FLOOR COVERING, hard-surfaced, is colored through entire thickness of its surface tread. It's said it doesn't become brittle or deteriorate, is waterproof and non-curling. Easy to clean, no need to cement it down. (12614)

• NEW PROCESS protects and preserves structural steel surfaces. After wire brushing, an inhibitor is applied, followed by primer and a synthetic paint. Said to be extremely durable and applicable to wide variety of corrosive conditions. (12615)

• LAMP with spare filament which goes into use when the first burns out is supposed to give electric light bulbs double life. Automatic switch within the bulb makes the switchover to second filament. (12616)

• PAPER FASTENER binds two to a dozen sheets of paper by interlocking them like a zipper. Two intermeshing rolls do the trick. (12617)

• LIQUID that dries into transparent protective film should be a blessing in the manufacture of products easily scratched. (12618)

Spot Welding Quality Isn't Up to the Operator

Pressure, current, time — control them and welds have to be good. Nothing is left to the operator's judgment at The National Cash Register Company, where spot welds can be duplicated within an accuracy of 5 per cent for strength

J. L. COCHRAN and P. F. ELDREDGE

Machinery Investigator

Foreman Punch Press Department

The National Cash Register Company
Dayton

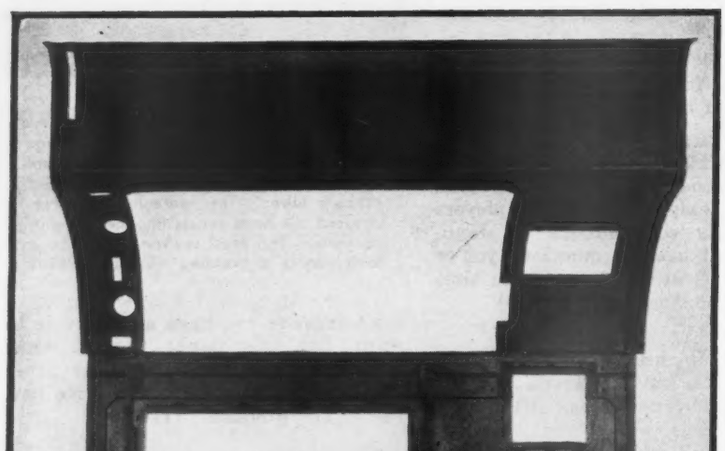


FIGURE 1. After test welds have been made, tested, and approved, a sample part is made up and filed for use at the machines, to show the operator what is wanted. Here, two views of a welded steel cabinet front. The front view shows the surface of the welds; the back, the welding specifications that are stamped on the part

WE HAVE been using resistance spot welding in the fabrication of steel cabinets since abandoning our brass ornamental cabinets about twenty years ago. The method of applying the low-voltage and high-amperage current has not changed, but there have been many changes in the electrodes, or welding points, and in the method of cooling them. From solid copper electrodes we have progressed to alloy copper points that are mounted

FIGURE 2. An office record card is kept for each part. It gives page number, part name, and other pertinent information. On the back are shown the welding specifications — transformer step, timer setting, and pressure. Once the specifications are set and followed, it is possible to duplicate welds within an accuracy of 5 per cent for strength

Operation	Transformer Step	Timer Setting	Pressure	Remarks
1006A	7TR	72-H	1850#	
1006A	6TR	60-I	1000#	

9531

Page No. Part Name 42000 Cabinet Front Date 9-11-35

Dwg. No. D-10974 Model 66-94

Oper.	Quan Used	Assembly Parts	Page No.
1006A	2	42000 Cabinet Lower Plate	65621
1006A	2	2000 Type Co Window Holder	1656
1006A	2	2000 Type Co Window Plate	1665
1006A	2	900 Key Guard Lower Gusset #2	65858
1006A	1	2000 Type F Footing Co Lower Plate	67885
1006A	18	42000 Cabinet Lower Plate #2	6442
1006A	1	42000 Window Support Plate #1	9501
1006A	1	42000 Back Window Support #1	100347
1006A	1	900 Round Nose Key Plate #1	102700
1006A	1	2000 Cabinet Bumping Plate #1	1665 (over)

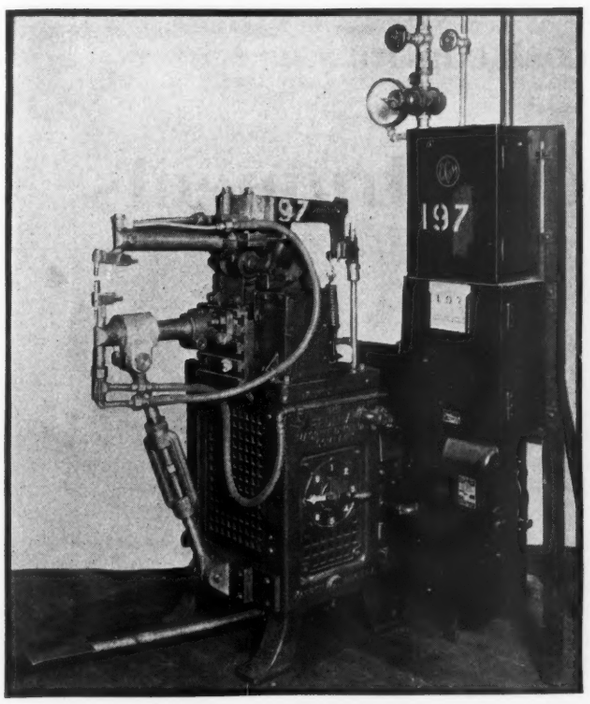


FIGURE 3. Spot welder ready to perform operation 306A on a steel cabinet front. Note the primary transformer has been set in point 7; the reducing valve to 50 lb. per sq. in. to give the desired 350-lb. welding pressure. With timer set at 70-H, with inlet and outlet water valves open, the machine is ready to weld

in water-cooled holders that permit the making of many welds per minute without pitting or burning the points for several hours.

The use of this method, although it was an improvement over previous methods, left a large amount of grinding to be done on the surfaces because of the depressions formed over the welds. Our next improvement, made to control the quality of the welding, was the introduction of projections on the parts to be welded to the cabinets. This permitted the use of flat finished electrodes top and bottom which gave us a much improved surface.

With these improvements our quality was still dependent upon the skill of the operators for applying the electric current the proper length of time before exerting the pressure necessary to make the weld.

No Human Equation

The introduction of electronic timers has enabled us to control the quality of our welding to the point where we are not dependent upon the human element. The timers permitted us to install an air-pressure control by which we regulate the proper pressure to be applied for each weld; since the pressure is constant and not instantaneous, it is applied at the proper time to make a good fusion of the metals.

The following is our method for obtaining quality control of our welded parts:

1. Parts to be welded to our cabinets are made with a raised portion at the point to be welded. This projection for the above work is 5/32 in. in diameter and rounded.

2. The pieces to be welded together are taken to one of our spot welders and some test welds made. After the men in charge have what they think is a good weld for appearance and strength, it is taken to the research division for test and approval. When approved, a sample welded part (Figure 1) is made up and a record kept on a card of varying factors, as shown in Figure 2. This card covers the page number, the name of the part, and location of tools and sample in the supply room. It also gives the welding specifications and lists as well the type of electrodes, noting particularly whether or not they are special. If so, they are filed with the fixture. The sample part is also stamped (see Figure 1) with the welding specifications—that is, welding transformer step (TR), timer setting (T), and pressure (P). This card (Figure 2) is our office record, and the sample is filed in the tool supply for use at the machines to show the operator what is required.

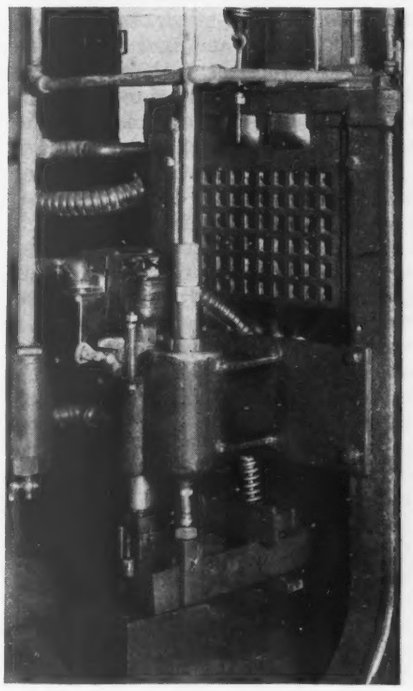
This Is the Way It Works

A description of the operation of our welder is as follows: From the record card we insert the proper electrode points and separate them the specified distance (Figure 3). We then set the primary transformer to point 7, and the reducing valve to the proper pounds per square inch—50 to give our welding pressure of 350 lb. on our 3-in. diameter air cylinder. The timer is then adjusted to the setting indicated on the card, 70-h; the inlet and outlet water valves are opened. We are now ready to weld.

This is the complete cycle of the machine: The operator places the work between the electrodes and then steps on the operating pedal, which brings the electrodes onto the work; the pedal is pressed down farther and the compressed air enters the air cylinder applying the predetermined pressure. The air valve then moves on to the full open position, and as it reaches the top it trips the electric switch that energizes the solenoid. This locks the air valve open and lets the current through to the electric contactor that engages and starts the timer to working. When the set time has been completed, the contactor is released; this in turn de-energizes the solenoid on the air valve. The air valve is then closed by means of the valve return weight that is fastened to its bottom. This permits the air to be exhausted from the cylinder.

Once the specifications have been approved, and followed, it is possible to duplicate our welds within an accuracy of 5 per cent for strength.

FIGURE 4. Rear view of welder, showing the air-control mechanism that is such an important factor in the quality control of spot welding



For quality and cost control

We Have to Use Instruments

F. D. EGAN
Superintendent of Electrical Department
Lackawanna Plant, Bethlehem Steel Company
Lackawanna, N. Y.

ELECTRICALLY operated instruments of various types have become indispensable to the precise control of operations now essential in many types of industry. Furthermore, industries that make extensive use of electrical energy are afforded an additional means of checking and controlling production operations through detailed records of power consumption, which are essential to prevent waste of power.

Instruments Everywhere

Our electrically operated continuous strip-sheet mill makes wide use of electrically operated instruments that directly record or control such factors as operating speeds or temperatures, as well as those that record current consumption. Both types of instruments make possible accurate control of rolling and of the many other operations involved in producing strip sheet. Among the instruments employed are watt-hour meters, a demand meter, horsepower meters, graphic and indicating ammeters, wattmeters, tachometers, indicating and controlling pyrometers, synchronized ship control systems and electric limit gages.

In a plant that utilizes electrical energy in the widely diversified ways and in the large quantities in which it is employed in continuous strip-sheet production, the control of power consumption is in itself a matter of great importance. For example, the twelve motors that operate the first stand of roughing mills represent a combined total of 36,000 horsepower. It is in these roughing mills that the hot slab coming from the heating furnaces receives its first reduction, passing in a continuous ribbon of hot metal to the finishing stands. From these stands the strip, which has now become cool, goes to a coiler where it is wound into coils for further processing and usually further reduction by cold rolling.

These processes utilize some 1,800 small or relatively small motors ranging in size from 1/10 to 250 hp., besides the main motors driving the mill, the largest of which is rated 4,500 hp., and the even more powerful motors on the motor-generator sets.

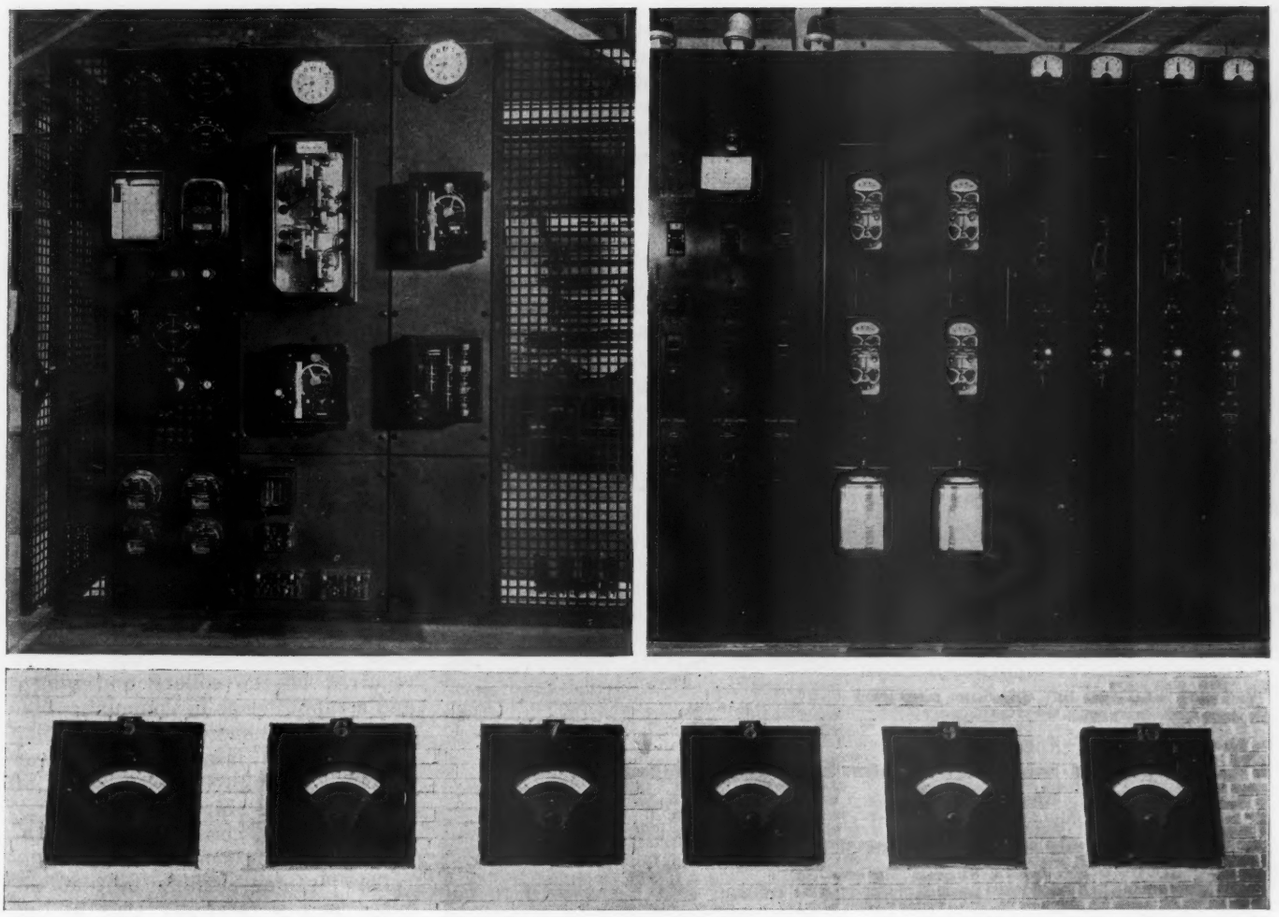
Quantity of electrical energy used per ton of finished steel is measured by four watt-hour meters on the four incoming lines along with a 15-min. demand meter that totalizes the energy flowing in the four lines and records on a tape the demand for each 15-min. period. These meters measure total energy for both the hot mill, where the metal is reduced in a hot condition, and the cold mill, where it is further processed and reduced in a cold condition.

Since it is desired to divide this total into divisions and subdivisions, so that energy costs for the various drives and processes can be determined separately, watt-hour meters have been installed to measure the energy consumed by each of the various motors involved. For example, watt-hour meters have been installed to measure the energy consumed at each of the roughing stands individually; the power consumption of the 6,600-volt, a.c. motors driving the 600-volt d.c. generators that supply energy for the finishing stands of the hot mill and the tandem and single stands of the cold mill; power consumption of the large 6,600-volt spray pump motors; the motors driving the auxiliary 250-volt d.c. generators; and the energy supplied by the 6,600/440-volt lighting transformers and the 6,600/440-volt auxiliary power transformers.

Auxiliary Power Also Measured

To obtain a breakdown of the auxiliary power used in individual processes, 100-millivolt ammeter shunts are used on d.c. drives and current transformers on a.c. auxiliary control panels. These make it possible to analyze individual drives with graphic test meters in order to determine energy consumption per ton. The same provisions for measuring energy consumption have been made on the pickling lines,

As the white-hot sheet leaves the last roughing stand it passes under two photoelectric cells, one of which is connected to a pyrometer at the right. The other cell actuates an indicating pyrometer in the slab furnace heater's pulpit



TOP LEFT
The two panels at the right carry the power company's meters. In the middle of the center panel is the totalizing watt-hour meter; below it are the 15-min. demand meter and test blocks. On the right-hand panel are a recording 15-min. demand meter; at the bottom, a totalizing watt-hour meter

TOP RIGHT
This meter panel carries the incoming line watt-hour meters, and graphic meters for recording the loads

ABOVE
Horsepower meters show the roller on the mill floor the loads on the six finishing stands

trimming units, splitting units, annealing furnaces, the flying shear which cuts the strip sheet while in motion, the cutting-up lines, and other individual processes and drives.

Although a large number of the meters are used primarily for checking and determining power costs, many of them are essential for smooth, efficient operation. Ammeters, kilowatt meters, and horsepower meters are used to indicate to the operators the loads of the scale breakers, roughing and finishing stands, edgers on the three roughing stands, pickling line, pinch roll motors, roll grinder motors, and two of the roller levellers. In the case of the edgers, horsepower meters are mounted on each of the universal stands. The meter scales are divided into three colored sections: White, indicating up to 100 per cent load; black, from 100 to 200 per cent load; and red, above 200 per cent load. These horsepower meters can be read by the roller on the mill floor.

For the pulpit operator there are an ammeter and a tachometer, calibrated in feet per minute, for each edger, whereby he can gage load and speed whenever a roll change requires resetting of the edger speed. For best results the edging roll speed must be kept about equal to the mill speed.

Tachometers Watch Speeds

In the case of the finishing stands, horsepower meters with colored scales similar to those on the edger meters are mounted on the side of the pulpit for the roller, whereas ammeters are mounted in the pulpit for the guidance of the operators.

Speed matching in the final set of rolls known as the finishing stands, through which the metal passes in the hot mill division, is highly important, since the strip is in several of the stands simultaneously. So tachometers are provided to indicate to the operator the speed of each finishing stand.

The flying shear operator also has an important speed-matching job. He has to match the speed of the shear with that of the last mill stand, in order to make the steel crop ends as short as practicable when coiling. Accurate speed matching is also necessary when heavier plate is being rolled in order to cut it to exact lengths. On the operating table, tachometers are mounted which indicate the last stand speed, runout table speed, shear generator speed, and the No. 1 shear motor speed in feet per minute. The shear operator also has a differential tachometer to indicate shear speed, fast or slow, in feet per minute, and a synchroscope for matching the speed of the last stand with the shear.

Tachometers also aid the coiler operator. Through them he is informed of the runout table speed and the coiler speed, in feet per minute. He can thus carry away the sheet with the coiler as fast as it is fed by the mill table, and thus avoid delays and losses due to sheets

At the flying shear operator's stand in the finishing pulpit are the tachometers and synchroscope for matching the speeds of the shear and the last stand

buckling and piling on the runout tables.

On the pickling lines tachometers are necessary for the same job of speed matching. The speed of the three driving pinch roll motors can be watched and matched by the operator to prevent too great sheet tension, which would result in tearing of the sheet, or too low sheet tension, in which event the sheet will be damaged by dragging in the pit.

In this instance the tachometers are also of much help to the production manager; with them he can check the operating speed of the line from the standpoints of production and quality of product.

Ammeters and tachometers are likewise used on the cold mill drives. On the tandem mills they are used for speed matching and load indication, and on the single-stand mills to indicate the speed of production and the rolling loads.

In some instances, for example on the hot mill stands, it is desired to have permanent records of the rolling loads. Hence, graphic ammeters have been installed on the d.c. finishing stands, whereas graphic wattmeters are used on the a.c. roughing stands. These instruments often provide valuable information in checking the percentage of reduction of steel through the various stands, and also in analyzing a mill when a cobble has occurred.

Temperature is an important factor in producing steel of the desired specifications; consequently, at several points in the production of strip, accurate recording, indicating, and controlling pyrometers are required. A table located between the roughing and finishing stands has two photoelectric cells focused on it. One of these is connected to indicate the slab temperature on a pyrometer located above the table operator, who is thus informed of the surface temperature before he sends the slab on to the finishing stands. The other "electric eye" operates an indicating pyrometer at the slab furnace, which serves to guide the heater in controlling the furnace temperature.

Since the temperature of the finished strip figures in sheet specifications, a photoelectric cell is also focused so as to record the temperature of each sheet as it leaves the last stand. A rapid-balancing potentiometer, in conjunction with an amplifier, magnifies the current of the photoelectric cell and records it on the chart. In this application a rapid-balancing potentiometer is required, so that the maximum temperature will be recorded before the sheet has passed the point. The pyrometer used is capable of full-scale deflection in two seconds.

Temperatures Just Right

Pyrometers are also used for controlling and recording the temperature of the acid baths used in the continuous pickling lines, and the temperatures of the box annealing furnaces. The arrangement of the controlling and recording instruments used for box annealing is extremely flexible. For each battery of fourteen bases there are five covers, each of which is provided with two controlling and one recording instrument. The wiring was laid out with plugs and receptacles in such a way that any of the controlling and recording thermocouples can be connected to any of the ten controlling or five recording instruments respectively.

Control wires for operating the motor-driven gas valves from the controlling instruments have been arranged so that they can be connected to the same cover, no matter which base it is on. This arrangement, by making it possible to operate all five covers regardless of their location on the fourteen bases, greatly speeds up production and makes the most efficient use of all the covers available.

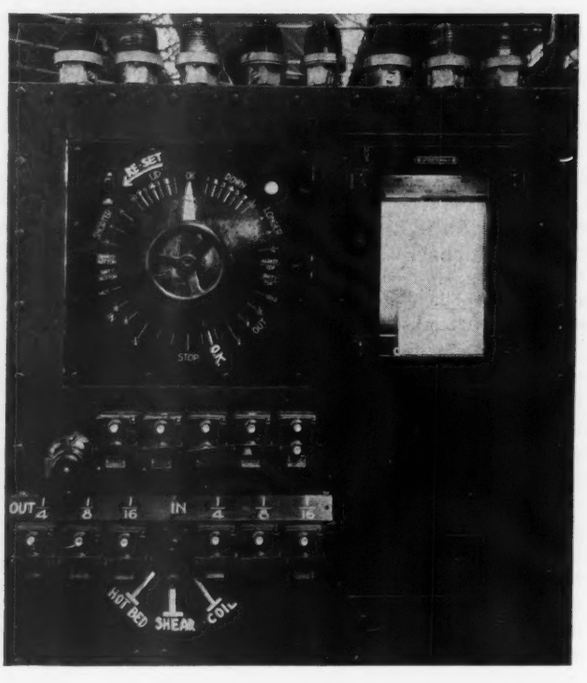
Telling It to the Roller

In order to produce products that meet the customers' specifications, close inspection of the hot steel is required at the coilers and pilers, and a rapid means of communication between the inspector and the roller of the hot mill is necessary. It was provided through the installation of a "Synchro-tie ship control system."

This system consists of three instruments—one sending unit at the coiler pit, one sending unit at the piler, and a receiving unit at the roller's stand, which is located at the last finishing stand. Each instrument consists of a large dial and a pointer.

In order to send a message, the

(Continued on page 86)



Synchro-tie ship control unit in the roller's pulpit of the last mill stand receives messages from inspectors at the coilers and pilers. At the right is the pyrometer that records the temperatures of sheets leaving the mill

Pick Floors for the Job You Ask Them to Do

J. F. ANDREWS
Assistant Editor

FLOOR surfaces are subjected to more widely varying usage than any other part of a building. For example, in some areas the floors must withstand heavy trucking and sharp blows from falling objects. Other floors are more or less continuously exposed to water or various acids and chemicals. In still other areas trucking, if any, is light, traffic is not heavy, and the chief requirement is that the floor surface be slightly resilient and a poor conductor of heat so that it will be as comfortable as possible for workers.

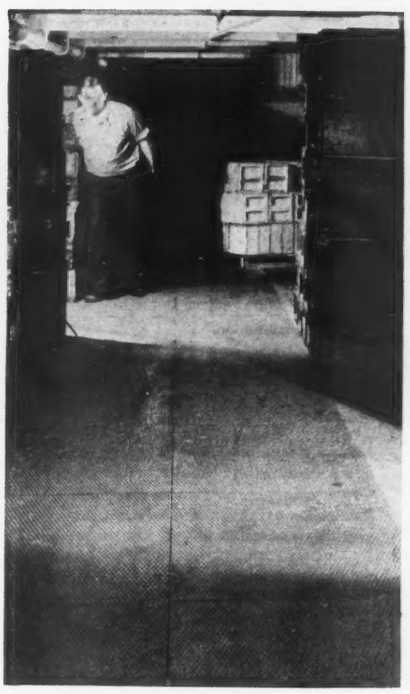
Where service is severe and a hard, rugged floor is needed, concrete, brick, or sheet iron are commonly used. Concrete floors are comparatively inexpensive, and will stand fairly heavy traffic. If heavy loads are to be trucked, it is advisable to use rubber-tired wheels. Concrete is attacked by acids, oils, and many chemical solutions; therefore, when subjected to these agents concrete floors must be treated to make them resistant, or protected in some way.

Brick surfaces are sometimes used in such places as forge shops and where traffic is very heavy. For such service it is advisable to use paving or other hard brick. Brick is long-lived and requires little maintenance, but is noisy when steel-wheeled trucks are used.

Acid- or chemical-resisting brick set in asphalt or similar material is frequently used where the floor is subjected to destructive liquids.

Where Trucking Is Heavy

Steel plates 3/16 or ¼ in. thick are more often used to protect floors at points where trucking is heavy or service unusually severe, than as an over-all surface. Smooth plate is slippery when wet, greasy, or dusty; hence the raised-pattern type is to be preferred. Inexpensive and easy to install, steel floor plate is long-lived and can be effectively used to protect any type of factory floor.



Steel floor plates with an anti-slip pattern protect the concrete floor in a trucking aisle

Clay-tile floors are relatively expensive and do not find wide use in industrial plants, aside from entrance lobbies, laboratories, or some departments where their ease of cleaning and ability to resist the action of water and chemicals make it economical to use them. Tile floors are hard and stand foot traffic well, but are cold and break down under heavy trucking and sharp blows.

So far as industrial use is concerned, terrazzo floor surfaces are in about the same position as clay tiles, being found mostly in office lobbies and halls. These surfaces are produced by mixing crushed marble or other stone or pebbles with cement and then adding water and laying the mixture in about the same manner as a cement floor.

An alternative method is to put down a mixture of cement and sand, with sufficient water to produce a plastic mortar. Crushed marble or other stone is then sprinkled over the surface and rolled in. In either case the surface has to be ground smooth with a surfacing machine.

Highly decorative effects are possible with terrazzo floors. They are durable and easily kept clean, but are cold and hard.

Composition and Wood

A considerable number of so-called magnesite composition floors are on the market. In general, they are composed of a mixture of magnesium oxide, asbestos, or other inert material, and pigment of the desired color. These dry materials are mixed with a solution of magnesium chloride to form a plastic mass which is troweled smooth and becomes hard in a few hours.

Magnesite composition floor surfaces range from ½ in. to 1½ in. in thickness and can be applied over wood, concrete, or steel plate subfloors. They are less expensive and less attractive than clay tile or terrazzo, but are more comfortable. Waterproof and easily cleaned, they stand foot traffic well, but are not adapted to heavy trucking or rough usage.

Wood floor surfaces are less hard and cold than those mentioned above and find wide use in the form of tongue-and-grooved, or matched, strips, and wood blocks. Matched floors can be laid over any type of floor construction. In wood frame buildings the flooring is nailed directly to the joists or to a wood subfloor. When a concrete or similar base is used, nailing strips embedded in the concrete or held down in other ways must be used.

A number of hard and soft woods are used for flooring, depending on the severity of the service and the effects desired. Where traffic is light, quarter-sawed fir, soft pine, or yellow pine will usually give satis-

Maple floors are well adapted to light and moderately heavy manufacturing and trucking . . . A wood block floor can stand lots of abuse and rough usage . . . Highly decorative effects can be secured by using blocks of different-colored woods . . . Floors made from pressed-wood-fiber boards look good in the office, are rugged enough for moderately heavy service in the plant

factory results. Of these woods, yellow or hard pine is more durable than the others, but cheaper and less durable than the hard woods.

Maple and oak are the most popular among the hard woods used for flooring. The hardness and close-grained structure of maple enable it to stand moderately rough usage. Hence it is widely used in areas devoted to light and moderately heavy manufacturing, as well as in offices and hallways.

Oak is classified as white and red. Both white and red oak flooring can be obtained quarter-sawed or flat-sawed. Quarter-sawed white oak is probably the most durable. In general, oak floors of the better grades approach maple in durability. Neither maple nor oak is adapted to heavy trucking. Both must be kept dry.

There is also on the market a synthetic wood which has several desirable characteristics. It is produced by breaking up wood chips into long fibres, which are felted or interlaced and then compressed and impregnated with oils. The thickness and hardness of the resultant board depends on the pressure used.

The grades used for flooring come in strips 48 in. long and 3, 6, 9, and 12 in. wide, and in 6 x 6-, 9 x 9-, and 12 x 12-in. squares. Strips are laid over other strips of a softer grade of the same material, to increase the resiliency. Squares are made up of three layers of the material, with a total thickness of ½ in. and are tongued and grooved. They are available in two colors, brown and black.

As a floor covering this synthetic wood will stand moderately heavy trucking and is adapted for use in areas devoted to light manufacturing. It is resistant to oil and water. Cost is comparable with that of matched hard wood flooring.

When the service is very severe, wood block surfaces can be used to advantage. Blocks are yellow pine or redwood cut and laid so that the grain is vertical. They can be obtained with or without a preservative treatment that will protect them from decay.

The thickness of the blocks ranges from 2 to 4 in., depending on the severity of the usage. They are laid on a bituminous or cement mortar cushion, and the spaces between them are filled with a bituminous compound.

In general, wood block floors are comfortable to work on, warm, quiet, and capable of withstanding a large amount of abuse. Since they are somewhat more expensive than matched hard wood floors and are not decorative, they are commonly used only in manufacturing areas and storerooms.

(A succeeding article, to be published in an early issue, will discuss some of the more common types of fabricated, resilient floor surfaces.—ED.)

•

INDUSTRIAL ELECTRICAL EQUIPMENT

A comprehensive review of recent developments in industrial electrical equipment will be presented in a January special section

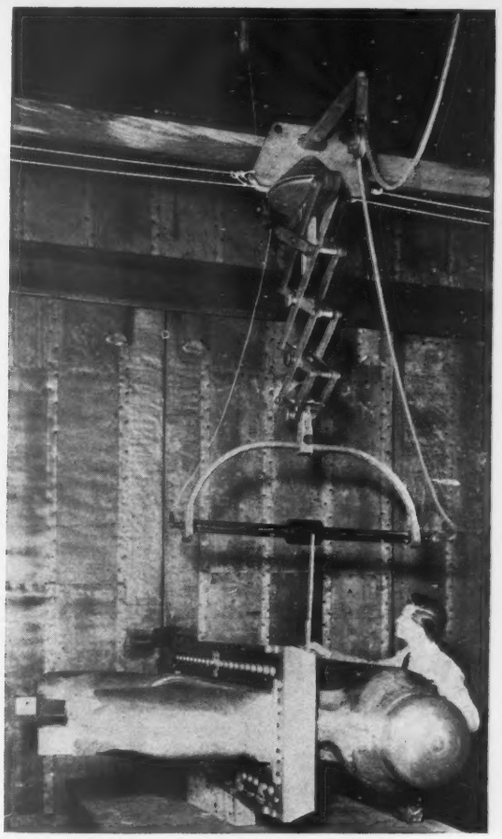
Twenty-Second in the Series of
FACTORY'S
PLANT OPERATION LIBRARY

•

X-Rays Tell the Inside Story

Finding one package containing a foreign substance out of 1,000 that didn't was easy for a tool that shows what can't be seen

H. I. TRENARY
Industrial Engineer, General Electric X-Ray Corporation
Chicago



When the X-ray does its work there won't be any question as to whether this turbine casting is free from objectionable defects

FORMERLY X-rays were used by industrial organizations largely for research; now they are recognized as an instrument for testing and for production control. Today nearly every manufacturer has some problem that might be solved by X-ray examination.

The principal difference between light and X-rays is that because of their shorter wave length the latter have the ability to penetrate objects opaque to visible light and thus reveal the internal structure. An X-ray beam will blacken a photographic film, produce fluorescence and phosphorescence in some materials, and ionize gases. The first two characteristics are used in industrial radiography to record the internal structure of objects, intensifying screens being placed in the cassette or film holder to supplement the action of the X-rays on the sensitized film.

The second property alone is also used for fluoroscopic examination of some products for which no permanent record on film is required.

Amount of absorption of the X-ray beam is proportional to the density of the material. This characteristic makes radiographic examination possible since a material of theoretically even density will produce a single degree of blackening on film, whereas any variation in density of an object will produce lighter or darker images.

The law governing absorption accounts for the variation in thickness of different materials that may be penetrated with a constant X-ray source. For example, aluminum 6 to 8 in thick can readily be radiographed, whereas a $\frac{3}{4}$-in. thickness of lead will almost completely absorb the output of a 400,000-volt X-ray machine, because it is so much more dense than the aluminum.

The longer wave lengths are more readily absorbed than are the shorter wave lengths; therefore the penetration of the X-ray beam may be controlled by changing the voltage applied to the X-ray tube. Because of the ultra-short X-radiation wave lengths it produces, very high voltage permits radiographic examination of comparatively dense material, whereas the use of a lower voltage is sufficient for examination of thinner sections of the same material or equally thick sections of a less dense substance.

First, for Inspection of Welds

One of the earliest and most widely recognized industrial applications of the X-ray was radiographic inspection of welded pressure vessels. Not until 1931 was electric arc welding approved for the fabrication of vessels subjected to high pressures and temperatures. In that year the A.S.M.E. Code for unfired pressure vessels approved fusion welding. It specified that test plates attached to vessels be welded with the same technique used in the construction of the vessels, and subjected to certain physical tests.

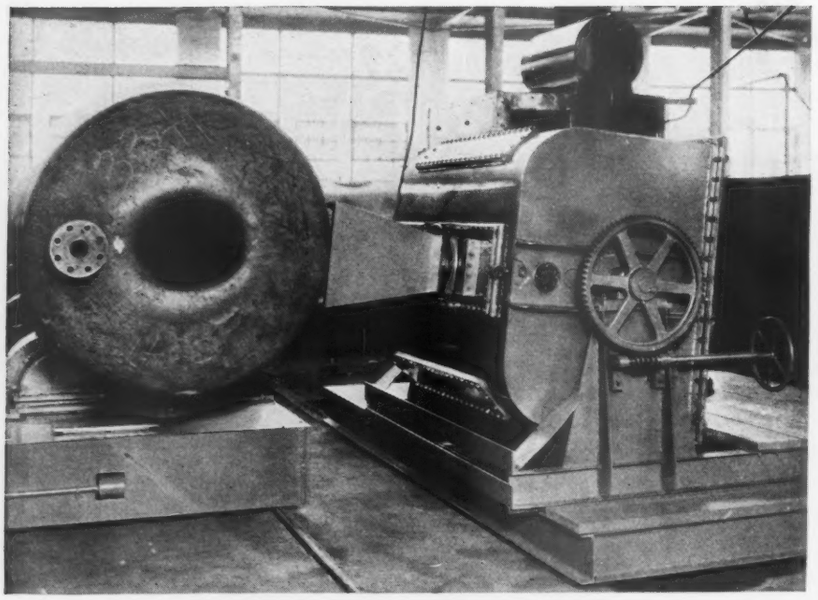
Since X-ray examination is the only non-destructive test that will disclose the internal soundness of welding, it was specified as the final check on the weld metal.

At first X-ray examination of welds in plate more than 3 in. in thickness was impracticable because of the limited capacity of the equipment. The first units operated at 220,000 volts. In 1935, 400,000-volt machines were built, permitting radiographic examination of welds in plate 5 in. thick.

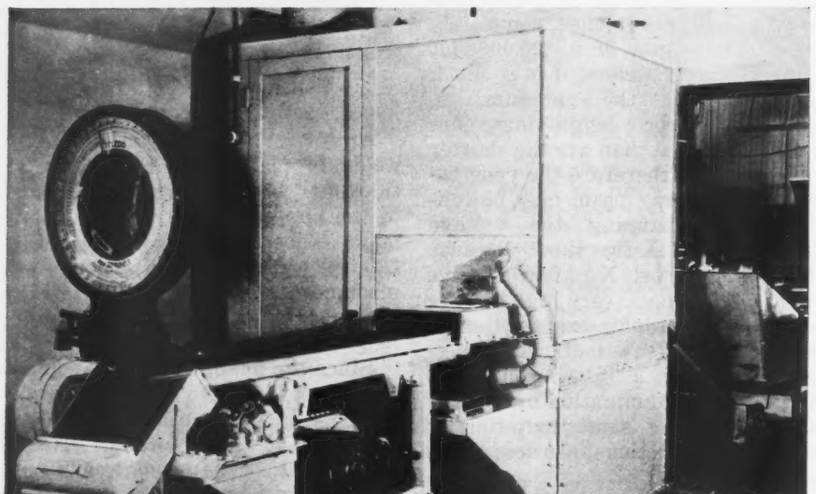
Since the adoption of X-ray examination of welded plate, approximately 20 manufacturers have installed 40 X-ray units. Nearly 800,000 ft. of fusion welding in plates from $\frac{1}{4}$ to $4\frac{7}{8}$ in. thick has been examined. The welded steel penstocks at Boulder Dam constituted the largest single welding contract to be subjected to radiographic inspection. This finished contract required approximately 75 miles of welding in steel plate from 1 to 3 in. in thickness. The penstocks of Morris Dam in the TVA project were also welded and X-rayed.

Not only is X-ray examination being used by the manufacturers of pressure vessels, but purchasers are examining the welds after they have been in service a number of years. This is especially true in the oil industry.

An X-ray examination will detect the presence of slag inclusions, porosity, lack of fusion, and cracks in parts up to 5 in. thick where the cross-section of the defect is at least



Ready to look into the quality of the welding on a tank. This is a 400,000-volt machine



A manufacturer of chocolates subjects all raw materials to X-ray inspection

2 per cent of the thickness of the welded section. In sections up to 1-in. thickness, defects 0.5 per cent of the weld thickness may be detected.

In the foundry industry, too, X-ray examination has found useful application. It has long been the practice to break up sample castings to determine the homogeneity and show types of defects present.

As in welds, X-ray examination of castings will show such types of faults as gas inclusion, sand and slag inclusions, cracks, pipes, spongy metal, and shrinkage. Under impact, castings do not always fracture at the points subjected to maximum stress in use, where homogeneity of metal is essential. X-ray examination, on the other hand, will show the location and extent of the defects. Then, by sectioning, a visual relationship may be obtained from the film image and the actual defect.

This method of examination can be used (1) for research to increase the foundryman's knowledge of proper technique; (2) to aid in the salvage of castings by welding; (3) to reduce the amount of metal in a casting; and (4) to increase the yield of metal from each melt.

Using pilot castings, foundry technique for a certain type of casting may be definitely established by radiography in order that sound castings of this particular type may be consistently produced. The X-ray film can often be a guide in changing the location of gates and rises to improve the soundness of the cast metal. Shrinkage at junctions of thin and thick sections may be studied and eliminated by the proper design of fillets.

The feeling that X-ray tests send more castings to the scrap heap is not altogether justified. Although castings may not be 100 per cent perfect, they may be entirely satisfactory for their intended use if the defects are not in areas subjected to shocks or severe stresses. Radiographic tests will either indicate the necessity for change in design or show that the castings can be used safely without change. Expensive castings can often be repaired by welding, and thus saved.

In many instances X-ray examination will show that gates and risers may be reduced in number, thus increasing the amount of salable metal from each melt. This is extremely important to the foundry because it reduces operating costs.

By the use of the X-ray and small-scale models one company recently developed a much better method of making a large casting. With the old method the yield was 38.5 per cent, whereas it is now 77.6 per cent.

From Radio Tubes to Candy

In other branches of industry the X-ray may be used for radiographic or fluoroscopic examination, or both. It is sometimes desirable to determine the relative positions of various parts of an assembly concealed in some container. For example, in the manufacture of large radio broadcasting tubes the correct position of each element is of vital importance. Since all of the elements cannot be seen, X-ray is used extensively to show them.

High-voltage bushings for transformers and oil switches may be radiographed to determine the solidity of the insulating material between the conductor and outer porcelain shell. Plastic molded parts containing metal inserts may be fluoroscoped to show the exact position of the insert.

The General Electric Company inspects fluoroscopically all sheet mica to detect impurities which may cause failures in service. Any defective areas are marked and cut out later.

Molded parts subjected to high

(Continued on page 88)

Again we say: Watch That Power Factor

It's much cheaper for a plant to furnish the magnetizing current for its equipment than to borrow it from the power company. A capacitor, for instance, is saving $90 a year in one small plant. Another that cost only $375 to install, saves $445 annually

HAMILTON BROOKS
Switchgear Engineering Department
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

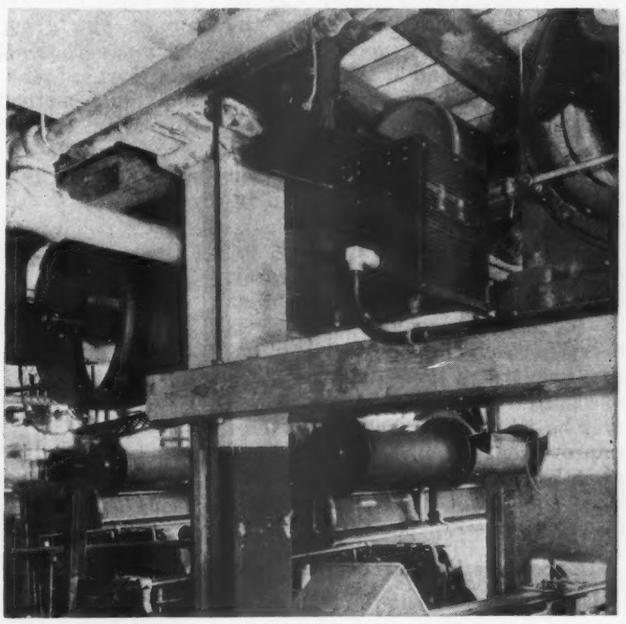


FIGURE 1. Mounted overhead and out of the way, a 30-kva., 460-volt capacitor helps a textile mill to keep power costs down

ENERGY borrowed from the central station to magnetize iron parts of induction motors, transformers, and other alternating-current equipment is measured in per cent power factor. In other words, this term is used to express the ratio between the power in kilowatts purchased and used up in doing useful work, and the total energy in kilovolt-amperes, including that used for magnetizing, taken from the line. Magnetizing energy is truly borrowed, since it is stored momentarily in the magnetic field of an a.c. machine and then returned to the power supply as the voltage alternates. This continued borrowing and returning of energy causes a flow of wattless or idle current, in addition to that required to do work, which uses up capacity and produces losses and heating in generating and distributing equipment just the same as the useful working current.

Borrowed magnetizing energy costs money. Magnetizing energy, or its effect on power factor, has been compared to such things as the froth on a glass of beer, the waste material in a sheet from which circular punchings are made, or the extra pull that a mule drawing a canal boat has to exert because he cannot walk directly in front of his load.

There is also a resemblance to the condition of a company having a steady income, but no working capital. Continued borrowing and repayment of funds, with the attendant interest and service charges, is necessary to carry on the business.

It Costs Money to Borrow

Just as funds borrowed to operate a business involve a service that must be paid for, so energy borrowed for magnetizing motors represents a service on the part of the power company that costs money and for which the user is charged. The charge for magnetizing energy, or low power factor, may be in the form of a penalty whereby the customer is charged at a higher rate for power if the power factor is below a given value. Or the customer may be given a reduction from standard rates if his power factor is held above a set value.

In another method no mention is made of power factor, but the power rate is based on the kva. demand. Since the kva. is determined to a large extent by the power factor, raising the latter to a higher value produces a reduction in the rate, just as though a direct bonus were given.

In improving power factor, or reducing the amount of magnetizing current needed for a given plant load, the first step is to make a check of the loading of such machines as induction motors and transformers. Loading of those that are doing less work than they are capable of performing should be increased. This is desirable because, although the magnetizing current of an induction motor increases with its size, it does not change greatly with its load.

For example, if a 100-hp. motor were carrying a 50-hp. load, its power factor would be on the order of 71 per cent, whereas if the same load were carried by a 50-hp. or fully loaded motor, it would operate with a power factor of 88 per cent. Substituting a smaller motor for a larger one that is lightly loaded, therefore, raises the power factor.

An improvement may also be made by substituting one large motor for a group of motors with smaller ratings, but in such instances other considerations involving the advantages of individual drives may outweigh higher power factor.

When the magnetizing current

requirements have been reduced to the minimum, the next step in a power factor improvement program is to arrange to supply the remaining magnetizing energy from within the plant. In some instances the most economical way to do this is to install synchronous motors, or substitute a synchronous motor for an induction motor. With proper excitation of its fields a synchronous motor can be made to supply part or all of the magnetizing energy needed by the other machines, and at the same time carry a useful load. Unfortunately, the synchronous motor is not so adaptable as the induction motor, and the number of places where it can be installed or substituted for an induction motor is restricted.

There is also the possibility of using a synchronous condenser, which is a rotating machine similar to the synchronous motor that is operated solely for power factor improvement and does not drive a mechanical load. Such a machine may be justified where power factor improvement requires several thousand kva. at one place. Conditions like this, however, are rare in the average industrial plant.

Capacitors Do It Economically

Use of capacitors is the economical way of furnishing magnetizing energy in most industrial plants. In effect, a capacitor is a storage vault for electrical energy. It operates in such a way that the storage of electrical energy takes place just at that interval during an alternation of the circuit voltage when the magnetic fields of motors and transformers begin to return their borrowed energy to the power system. When a capacitor of the proper size is connected in the circuit, the result is that the initial charge of energy taken from the line by a motor is not returned to the power system but is stored in the capacitor and used over and over again.

The capacitor is quiet in operation, has no moving parts, and its storage of energy is performed with a loss of only a few tenths of a per cent. It is commonly supplied in units or cells of 5- to 15-kva. capacity, which are used singly or in banks, as required. In a small plant a single unit may be all that is needed. It costs little to install, is connected directly across a motor's terminals, and is operated through the motor switch. When the motor is started the capacitor is automatically placed on the line to provide the magnetizing energy; when the motor is switched off and the magnetizing energy is no longer needed, the capacitor is disconnected with it.

A capacitor of this type, rated at only 3 kva., is saving $90 a year for one small plant. In another location a 15-kva. capacitor installed at a cost of $375 saves $445 a year.

It is usually better practice to use multiple units, or a bank of capacitors centrally located, than individual capacitors for each motor. In almost any group of motor-driven machines there are some that are idle part of the time. With the individual method of power factor correction each capacitor must be large enough to provide the magnetizing energy for its particular motor and, since it is switched off with the motor, it is put to no use when the motor is not running.

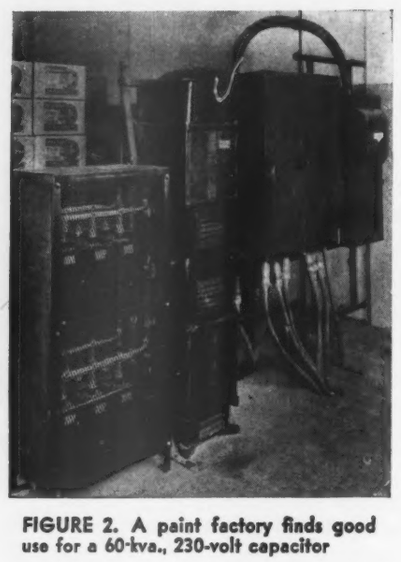


FIGURE 2. A paint factory finds good use for a 60-kva., 230-volt capacitor

A bank of capacitors, on the other hand, may be installed to serve a group of motors, or be connected at a particular load center. Under these conditions the total capacity need only be large enough to provide the improvement needed for the average motor load; hence a distinct saving may be made in capacity, compared to that needed for each separate motor. A small installation of this class, shown in Figure 1, is rated 30 kva., 460 volts.

Here the capacitors are placed in an out-of-the-way location near the ceiling. Such an outfit installed by one manufacturing plant at a cost of $432 saves $17.50 a month, giving a return on the investment that will pay for the capacitor in slightly more than two years.

A large capacitor rated 60 kva. at 230 volts is shown in Figure 2. An installation with a rating of 120 kva., reduced the power bill of a plant $200 a month and paid for itself in only fourteen months.

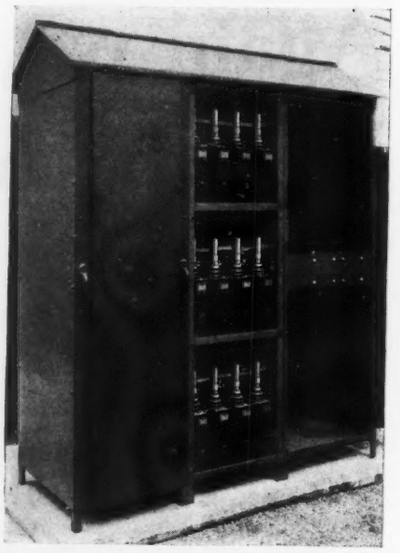


FIGURE 3. Here it was more convenient to install the capacitors out of doors. They're rated 480 kva., 4,000 volts

In large factories composed of several separate buildings and having a number of load centers, it is often best to install a capacitor bank at each load center to serve a particular building or floor. In this way the capacitor can be placed relatively close to the machines for which it furnishes magnetizing current. If the circuits from the substation are heavily loaded, important advantages in the way of added reserve capacity of the lines, and lowered line losses may be secured by the elimination of the magnetizing current.

Benefits Are Many

A manufacturing plant installed more than 1,000 kva. in capacitors in this manner, with individual installations of 120- to 180-kva. capacity. Aside from a return for power factor improvement which paid for the investment in less than 1½ years, definite benefits in the form of better voltage regulation and reduced line losses were obtained. Furthermore, the installation of additional cable which would have been necessary because of increased loads was avoided.

Where circumstances make it desirable, capacitors may be obtained in outdoor housings (Figure 3) and located in a yard or substation. Another type of housing permits the mounting of a capacitor on a pole beside a transformer bank. With this adaptability there is no problem in finding a suitable location for a capacitor installation.

Operating Shorts

Two Pulleys Needed, Room for One

DAVID FLIEGELMAN, *Worcester Mass.*

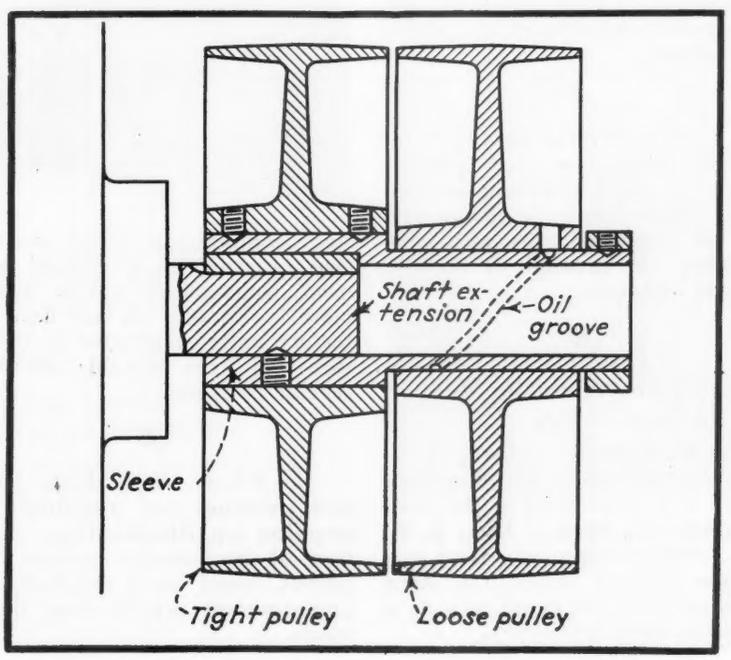
After moving one of our machines to a new location it was found advisable to do away with the countershaft. However, this could be done only by installing tight-and-loose pulleys on the shaft extension of the machine. As it happened, the shaft extension was long enough for only one pulley. The sketch shows how the two pulleys were installed under these conditions.

A steel sleeve was made with the bore just large enough to fit tightly over the machine shaft extension, and an internal keyway cut to suit the old key. The length of the sleeve was sufficient to accommodate the two pulleys and a shaft collar. Then the removable bushing was taken out of a pulley of the required diameter, and the large end of the sleeve was turned down so that the pulley fitted snugly over it. The small, or outer, end of the sleeve was turned down to a running fit for the loose pulley.

The next step was to slip the sleeve over the shaft extension and secure it in place with the key and a setscrew. After forcing the tight pulley into position it was fastened with two setscrews. When the loose pulley had been put in place the shaft collar, which holds it, was put on.

To provide lubrication for the loose pulley, oil grooves were cut in the outer end of the sleeve. The former setscrew hole in the loose pulley now serves as an oil hole.

Mr. Fliegelman's contribution has been awarded the $10 *payment offered by the editors for the best Operating Short submitted during the past month.*



•

When Quarter-Turn Belt Drives Give Trouble

W. H. MOORE, *Hamilton, Ontario*

The belt connecting a horizontal and vertical shaft is sometimes the source of much trouble. Unless everything is just right it will not stay on the vertical shaft pulley.

Sometimes the belt will slip off after it has been running satisfactorily for a considerable time. The cause is usually found to be uneven stretching of the belt. One side has become somewhat loose, and the belt works off the pulley, always at the same side.

One remedy is to turn the belt around so that the side that was on top as it went on the vertical shaft pulley is now underneath. If this expedient does not work the pulley may be shifted up or down, disregarding the center, until the belt stays on.

On quarter-turn drives the pulleys must be perfectly true. A vertical shaft pulley that rocks will fail to hold the belt under any load. An emergency method of making a belt stay on the pulley is to offset the joint. That is, instead of the ends of the belt butting together in line, they are set out of line about ¼ in. As the joint reaches the vertical shaft pulley it rises or drops a little, depending upon which side the belt has been slipping off.

No hard-and-fast rules can be laid down for curing quarter-turn belt drive troubles because the condition of the belt and pulleys, their size, and the method of joining are important factors that vary in each installation. Much trouble can be avoided, however, by cutting a smooth groove with nicely rounded edges in the middle of the crown of both pulleys, before installing. The belt will hug a pulley face grooved in this way much better than a plain face.

One safety-minded manufacturer, determined to eliminate eye accidents on grinders, installed a goggle tray and sensitive switch on each grinder. As long as goggles rest on tray, grinder cannot be operated. When operator puts goggles on, the machine can be used.

One Man, One Day, Reclaims 600 Gallons of Oil

SOURCE, *Chevrolet Motor Company Muncie, Ind.*

Handling of chips from machine operations is combined with oil reclamation at the Muncie Plant of the Chevrolet Motor Company. One man does all the work.

Chips and turnings from each of two kinds of steel, and from gray iron, are kept separate throughout. The material is handled by conveyor and eventually dumped into steel tubs which are moved from the end of the conveyor to the oil reclamation building on lift trucks. Here the containers are hooked to an electrically operated monorail and hoisted. The contents are dumped into a centrifugal agitator which wrings the oil from the chips and permits it to flow off. This oil is then put through a separator which not only removes foreign solids but also gets rid of the soap water and other liquids, that do not belong. From here it is pumped into overhead tanks, and then barreled for re-use.

Three different kinds of cutting oil are used in the plant, varying in lard oil percentage. The mixture salvaged by the reclamation work runs from 6 to 8 per cent lard oil, which gives a superior blend for those machines using a general-purpose cutting oil.

When the chips have been wrung free of oil in the centrifuge, they are hoisted on the monorail and dumped into one of three chutes leading to the basement of the oil reclamation house. Here they are crushed and elevated in bucket conveyors to one of three overhead bins —one bin for each of the three kinds of material. When the bin is full, a car is spotted beneath its spout, and the chips flow into the gondola.

The system does away with all the ordinary equipment for handling chips, including trailers, tractors, and so on. It eliminates all manual handling. One man does all the work both of reclaiming the cutting oil and also of storing and loading the chips, of which there are about three cars a week when the plant is operating to capacity. For the wages of one man, plus the cost of running the equipment, 600 gal. of cutting oil are reclaimed daily, and three cars of chips are loaded weekly for shipment.

Hot summer days cut output at hammers and presses where hot metal was being worked 50 to 70 per cent. A blower system for each machine unit, distributing air through 5 outlets, worked wonders.

Manager Moves to the Men in His Steel Office

LEROY W. ALLISON, *Newark, N. J.*

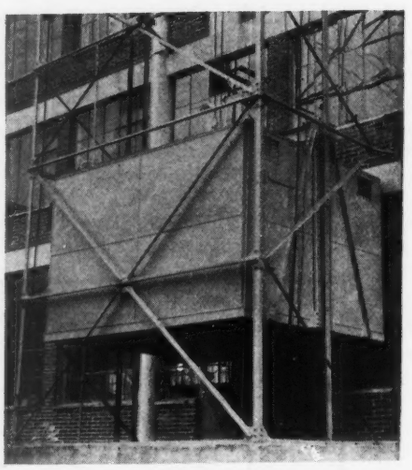
A movable office for executive service is an innovation at the shoe-manufacturing plant of Bata, A. S., Zlin, Czechoslovakia. Located outside the building proper, this office moves vertically, as an elevator, in a structural steel framework.

Constructed with heavy-gage metal siding and roof sheets, and substantial steel floor, the office is 13 ft. long, 11½ ft. wide, and 8 ft. high. It is insulated, ventilated, and electrically heated. Furniture and fixtures are of steel, and interior walls are painted white.

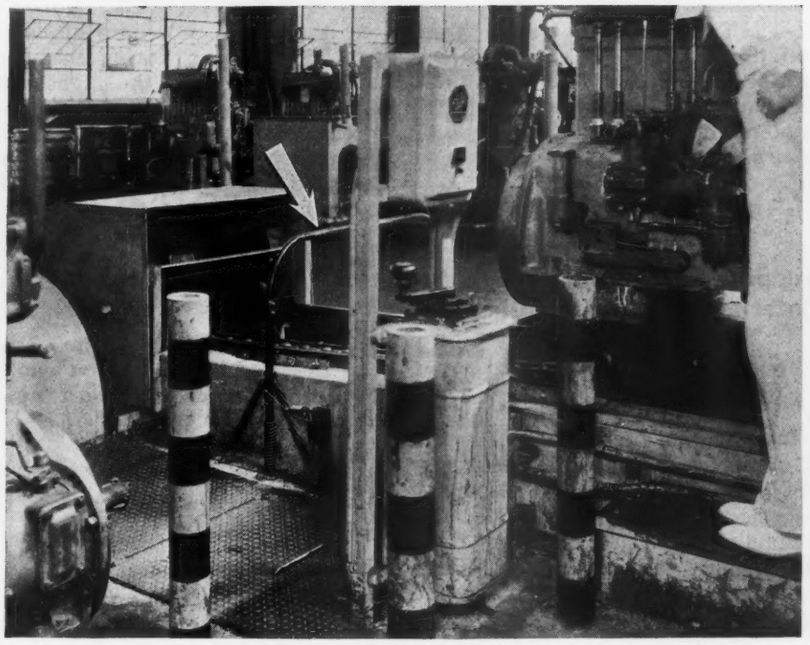
On the desk is a control board where pressure on a pushbutton starts the office moving. It stops automatically at the floor desired, and doors leading from the office to the building are automatic in operation too. Available are all communicating devices such as telephone and auto-call. These can be used at all times, regardless of whether the office is at rest or in motion.

As a result of a study which showed that departments located near the manager's office operated more efficiently than those at a distance, this movable office was conceived. Now, conferences between the plant manager and shop foremen can be held at any floor, and the conferees can be assembled quickly. Ten men can be accommodated at one time.

Because of the success of this first unit, two such offices are to be installed on a new 15-story administration building now under construction. In addition to vertical movement, these offices will be able to move horizontally on any floor. All factory units constructed in the future will have movable offices as regular equipment.



Where both high speed and accuracy are required, try stepping up illumination. Addition of foot-candles lowers "apparent speed" — a psychological phenomenon which has dollar value.



Where a Trip Saves a Smash

SOURCE, *Caterpillar Tractor Company Peoria, Ill.*

At the end of the diesel engine assembly line a reliable automatic shutoff was needed. Without such a shutoff there was danger of an engine being dumped, if for some reason or other it was not earlier removed from the line.

The problem was complicated by the fact that flat-top steel dollies which carried the engines during assembly were integrally fastened to the moving chain.

An automatic trip in the form of a yoke made from pipe is the solution worked out. Wide enough and high enough to pass the dolly through, this yoke is low enough to be tripped by any engine left on the line.

Where climatic conditions affect quality, don't overlook advantages of air conditioning.

Effective Control of Stockroom Lighting

Go into the average stockroom. In all probability you'll find it laid out with long aisles and short aisles at right angles to each other. That's good layout. You'll probably also find that the natural lighting isn't very good. That can't be helped; high tiers of bins do shut out light.

But if you find that stock-keepers have to pull individual lights on and off one after the other, or walk the full length of an aisle to get at a switch for the row, you'll know that even the artificial lighting isn't what it should be.

In the accompanying picture a stock-keeper at Warner & Swasey, Cleveland, is shown just after he has pulled a switch. When he did so, he

turned on all the lights in one aisle. Suppose the stock he wants is near the other end. He can get what he wants and leave the aisle at the other end, pulling a switch as he does so to put out all the lights in the aisle.

This kind of control is installed for every aisle in the stockroom—both the long main aisles and the short secondary aisles.

•

Fewer Men, Fewer Accidents with Automatic Press Devices

R. A. SHAW, *Safety Engineer*
Murray Corporation of America
Detroit

We have three large press rooms in each of which there are many large presses requiring three to five operators and helpers apiece. These presses range in size from 60 to 100 tons and they operate at 200 to 300 strokes per hour, with some of the smaller ones going as high as 500 strokes per hour.

The old problems of reducing accidents and manpower came up. To accomplish the latter, tripping devices were installed, eliminating the tripping operator. With these, one operator can trip the press by pressing a button; by button control the press can be stopped more quickly than with lever control, and the method removes a chance of accident caused by fatigue or inattention on the part of the tripping operator.

To reduce accidents, multi-button controls were installed. Each operator and helper has a button to press. When all are ready, they press the buttons, and the press functions. This system eliminates the type of accident where the principal operator tripped the press when he thought all were ready. Often to everyone's dismay he found that someone had reached back to straighten the stock, only to have his hand caught as the press closed.

•

SPECIAL NOTICE

•

$10 will be paid for the best Operating Short submitted during the month of December. The Editors are the judges. Other Shorts accepted will be paid for at attractive rates

When conveyors meet—here two merge their contents in a roller chute. Two rollers on vertical guides, rising and falling alternately, control flow of packages, prevent interference

•

When Cutting Corners Is Profitable

SOURCE, *Acklin Stamping Company Toledo*

Trimming corners of punch holders on sheet metal dies is being done in this plant. Purpose behind this practice is elimination of the hazard of having the operators' hands or wrists squeezed between the clamping-bolt heads and the punch holder. At the same time, it affords better light and consequently greater visibility at the point of operation. This makes for greater safety. It also decreases the weight of the die and makes it easier to handle. Finally, it has been found conducive to lower operating costs.

However, it is impractical to cut these corners off until the die has been made, as many times the full face of the punch holder is required in completing the die.

The Acklin plan is to try the die after completion, mark off any protruding corners beyond the ram and working steels, and cut them off with a saw or burn them off with a torch. If the latter method of burning is used, particular care is exercised at all times to keep the flame a safe distance from the cutting or forming edges, to eliminate any chance of annealing the working edges.

From the experience so far, it appears that the operators like the idea so much that they are voluntarily taking the lead in pointing out to their foremen punch holders that can be trimmed in this fashion.

Too frequent calls for donations when one of their number died led members of the supervisory group in a New England plant to purchase group insurance.

Keeping an Eye on Idle Materials Reduces Spoilage

N. E. HURST
Assistant to Comparison Manager
Rowntree & Company, Ltd.
York, England

Investigation in one department of our plant disclosed the fact that 1.86 per cent of the material entering the department was spoiled or contaminated to such an extent that it had to be sold as scrap material. Each unit sold in this way represented a loss of 15/.

Further investigation showed that two products produced under mass production conditions 24 hours per day, each product involving a team of approximately 50 people, were mainly responsible for this loss. Type of product, type of labor employed, and the striving for still greater production were chief causes of the trouble. Temporarily surplus material was left around the machines for long periods. Because of its nature and owing to the lack of personal responsibility, this material soon became spoiled for its original purpose, or was contaminated by mixture with other materials.

By the simple procedure of delegating to one man during the day and one man during the night the task of removing material as soon as it became temporarily surplus, the percentage of material spoiled or contaminated has fallen to 0.60. Net saving has amounted to £727 ($3,679) in twelve weeks, or approximately £60 ($304) per week.

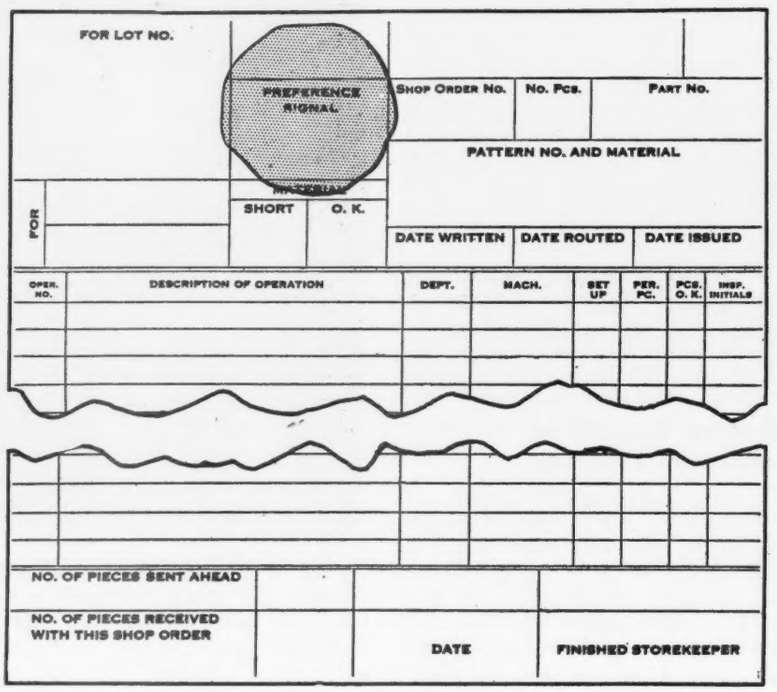
An "old" machine has been described as one that can't produce as efficiently as a new one.

Envelope Keeps Orders and Blueprints Together

E. GRAFF, *Graff Machine Company*
Tonawanda, N. Y.

Used with excellent success by several firms, this routing envelope combines the advantages of routing cards and route sheets with a means of carrying along the blueprint that is to be used in performing operations called for on a production order.

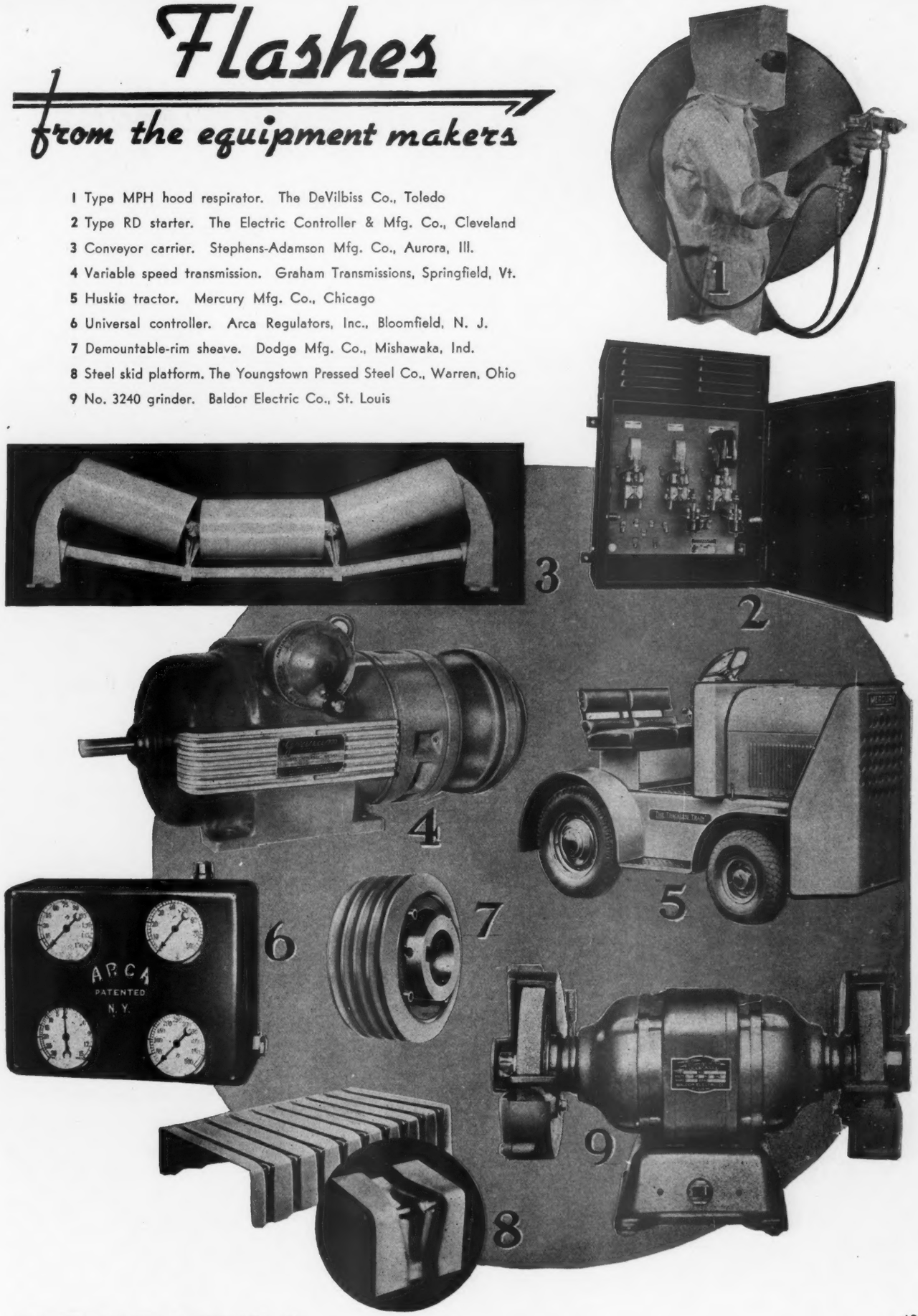
It provides for all information necessary to the carrying out and recording of the operations. The shaded area at the top represents a gummed red signal attached to indicate that the order is to be given preference and rushed through. If the order is routine, the signal is left off. The envelope shown is 9½ in. long, 6½ in. wide.



Flashes

from the equipment makers

1 Type MPH hood respirator. The DeVilbiss Co., Toledo
2 Type RD starter. The Electric Controller & Mfg. Co., Cleveland
3 Conveyor carrier. Stephens-Adamson Mfg. Co., Aurora, Ill.
4 Variable speed transmission. Graham Transmissions, Springfield, Vt.
5 Huskie tractor. Mercury Mfg. Co., Chicago
6 Universal controller. Arca Regulators, Inc., Bloomfield, N. J.
7 Demountable-rim sheave. Dodge Mfg. Co., Mishawaka, Ind.
8 Steel skid platform. The Youngstown Pressed Steel Co., Warren, Ohio
9 No. 3240 grinder. Baldor Electric Co., St. Louis



What's NEW in Equipment

Air Conditioning, Ventilating, Heating

AIR DISTRIBUTOR—Reduces speed of air flow so that there is no perceptible draft. Consists of hollow flaring members placed within or in front of each other. Can be combined with lighting fixtures. Three types: A for velocities up to 5,000, B to 4,000, and C to 2,500 ft. per min. Anemostat Corp. of America, 551 Fifth Ave., New York.

FAN—Ventilating fan is belt-connected to motor mounted on vibration-absorbing base. Fan speed can be varied by 25 per cent. Three types. American Machine & Metals Mfg. Corp., 100 Sixth Ave., New York.

FILTER—"Permo Pad." Made of fibrous material, packed loosely on side where air enters, with progressively increasing density toward the back face where a stiffening piece of expanded metal is imbedded in the material. Easily cleaned. Independent Air Filter Co., West Ohio St., Chicago.

UNIT HEATERS—"Airvector." Redesigned line of unit heaters. Have new method of mounting motors designed to eliminate swinging action caused by motor vibration. Airtherm Mfg. Co., 1474 South Vandeventer, St. Louis.

Bearings

BALL BEARINGS—Type X duplex ball bearings for high-speed-grinding spindle applications. Can be installed by user face-to-face, back-to-back, or tandem. Nine sizes. The Fafnir Bearing Co., New Britain, Conn.

BEARING MOUNTING—CJB-Simplex ball bearing housing mountings. For use in equipment where housing is either part of machine or must conform to manufacturer's design. Three capacities for given shaft size; for shaft diameters ranging 9/16-3½ in. Ahlberg Bearing Co., East 29th St., Chicago.

Communication and Signaling

PAGING SYSTEM — Model 111 paging system. Equipment includes speakers, amplifiers, microphone, and a footswitch. Any number of speakers can be had for parallel connection in 2-wire circuit. Amplifier operates from 105-125-volt, 50-60 cycle supply. Operadio Mfg. Co., St. Charles, Ill.

RELAY — For signal and call systems. Operating range from 4½ to 50 volts d.c. Consumes 12 watts. Dimensions are 2⅝x1x-1½ in. Guardian Electric Mfg. Co., West Walnut St., Chicago.

SIGNAL LIGHTS—Two improved designs in line of Glowlites. Fit standard 4-in. outlet box; take bulbs in sizes from 25 to 100 watts. Clear or colored lenses. Lintern Corp., Lorraine Ave., Cleveland.

Electrical Control

CONTROLLER—Time-cycle controller has two mercury switches operated by motor-driven cam. Can be connected for single-pole, double-throw application or operated in two independent load circuits. Speed of operation can range 16-60 cycles per min. Electric Switch Corp., Columbus, Ind.

RHEOSTAT—D-150 rheostat with rating of 150 watts. All live parts but the terminals are inclosed. Measures 4 in. in diameter, and depth behind panel of 1½ in. Hardwick, Hindle, Inc., Pennington St., Newark, N. J.

STARTER—Type RD Direct Current Mill Type Starter for motors ranging 5-25 hp., 230 volts. Has mercury acceleration relays permitting time range of ½-2 seconds per step. Has 3-coil resistor mounted on top of cabinet. The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland.

STARTERS AND CONTACTORS — Type CM magnetic starters and contactors for 1½-25-hp., single or polyphase motors. Have self-cleaning, self-aligning contact action. Interchangeable relay heaters. The Trumbull Electric Mfg. Co., Plainville, Conn.

SWITCHES—Front-operated, general-purpose, type D safety switches for use where midget switches are desirable and side-operating switches cannot be used. Available in 2-pole NEC and plug fuse sizes, also 2- and 3-pole solid neutral. Westinghouse Electric & Mfg. Co., East Pittsburgh.

SWITCHES—Type A inclosed motor-disconnect switches with double-break heavy contacts with fiber arc snuffers. Available with 2, 3, or 4 poles in capacities of 30-200 amp., for a.c. or d.c. Ward Leonard Electric Co., Mount Vernon, N. Y.

SWITCHGEAR — Type RA Metal-Clad switchgear. Three-phase. All live parts are steel inclosed. Has 5-kv., 600-amp., 25,000- and 50,000-kva. oil blast circuit breakers. Can be mounted in banks of 2 or more units. Delta-Star Electric Co., 2400 Block, Fulton St., Chicago.

TIME SWITCHES—Two Sauter synchronous-motor time switches. Both are offered in 4- and 30-amp. capacities for 110- or 220-volt circuits. Model SY has all-metal housing; Model SW is designed for mounting in standard meter socket. R. W. Cramer Co., 67 Irving Pl., New York.

VOLTAGE REGULATOR — Type REF booster voltage regulator. Suitable for meter standardization, calibration work, and for holding voltage of battery chargers constant. In 2½-, 5-, and 7½-kva. sizes: single-phase, 120- or 240-volt types. Roller-Smith Co., 233 Broadway, New York.

Electrical Distribution

TRANSFORMER—Type T potential transformer with thermal capacity up to 200 volt-amperes. For voltages up to 6,900, 25 or 60 cycles. R. E. Uptegraff Mfg. Co., 300 North Lexington Ave., Pittsburgh.

Electrical Protection Devices

CIRCUIT BREAKER—"Turbulator." An oil circuit breaker for indoor service. Operates at 600-2,000 amp., 7,500-15,000 volts. Class 50-TCR-1 has interrupting rating of 50,000 kva., Class 100-TCR-1 of 100,000 kva. Can be installed for manual or electrical operation. Roller-Smith Co., 233 Broadway, New York.

PANELBOARDS—"Multi-breaker" lighting panelboards. Supplied with from 4 to 40 circuits in 2-circuit groupings for 115, 115/230 volts a.c. Single-pole branches for 15, 20, 25, or 50 amp. Dimensions: 15 in. wide by 4 in. deep. Square D Co., Detroit.

Exhaust Systems

DEWATERING TANK—For use with wet dust collector units. Dewaters accumulated sludge in settling cone of multiwash dust collectors. Water containing solids enters through baffled section to prevent disturbance. Constant level is kept by weir over which excess water passes as additional water flows into tank. Claude B. Schneible Co., 3951 Lawrence Ave., Chicago.

Filtering, Clarifying, Mixing

OIL EXTRACTORS—Improved design of line of centrifugal oil extractors. Direct-connected motor drive. Lid cannot be opened while machine is rotating. Force-feed lubrication. National Separator Co., Grafton St., Worcester, Mass.

STRAINER—For continuous removal of suspended solids from liquids. Consists of inverted, hollow, cone-shaped, perforated cylinder revolving slowly within a cast iron housing. Perforated areas in cylinder contain filtering elements. H. A. Brassert & Co., 310 South Michigan Ave., Chicago.

Food

ICE CRUSHER-SLINGER—For top-icing bottled milk and beverages, fish, vegetables, and other products with snow ice. Series 100 has capacity of 7½ tons hourly; Series 200, 15 tons; Series 300, 30 tons. Has high velocity discharge. Link-Belt Co., 2410 West 18th St., Chicago.

Grinding and Buffing

CUTTER GRINDER—No. 10 cutter and tool grinding machine requires only one operating position. Accommodates all usual cutter types and sizes. Has constant-speed, dustproof motor, V-belt drive at 3,760 or 4,380 r.p.m. Brown and Sharpe Mfg. Co., Providence, R. I.

GRINDER—No. 3240. Has capacitor-type motor which, it is said, can be repeatedly overloaded without burning out. Rated at ½ hp., 3,450 r.p.m., single- or three-phase. Wheels are 7 in. in diameter. Closed guards, clearance-type motor frame. Baldor Electric Co., 4357 Duncan Ave., St. Louis.

GRINDERS — Line of heavy duty, tex-drive, snagging grinders. Entire assemblies of wheels and flanges may be removed for transfer as an integral unit. Four sizes: 5, 7½, 10, and 15 hp. Fifteen types. Hisey-Wolf Machine Co., Cincinnati.

GRINDER AND POLISHER — Horizontal belt grinding and polishing machine. Can be used wet or dry. Flat work 46x26 in. can be supported on adjustable table. Belts may be any width up to 5 in. Oliver Machinery Co., Grand Rapids, Mich.

GRINDING WHEEL—"B-E" bond wheel for tool grinding. Has cool, free-cutting action. For surface, centerless, and other grinding operations. Norton Co., Worcester, Mass.

Instruments and Meters

CIRCUIT TESTER—For testing circuits of a.c. and d.c. communication lines. Measures voltage, milliamperes, and ohms. Scale length of 2½ in. Weighs 14 oz. Rotary switch at front permits selection of proper scale. Ferranti Electric, Inc., 30 Rockefeller Plaza, New York.

CONTROLLER — Regulates pressure, vacuum, flow, liquid level, or temperature. Has movable fulcrum which can be set at different points on moving arms to control different mediums. Has four dials indicating air supply, pressure, reduced pressure, setting of compensator, and reduced steam pressure. Arca Regulators, Inc., 111 Orange St., Bloomfield, N. J.

HEIGHT GAGE—Measures height above table. Vernier makes possible readings to thousandths of an inch. Recessed base is ground and lapped square with vertical standard. Standard range is 18 in. but can be supplied in 24- and 36-in. lengths. L. S. Starrett Co., Athol, Mass.

MEGOHMMETER—Type 487-A. Direct-indicating, it has range of 20,000 to 50,000 megohms. Uses vacuum-tube voltmeter for indicator. Power obtained from 115-volt, 42- to 60-cycle a.c. line. General Radio Co., State St., Cambridge, Mass.

TESTING MACHINE — Tests cylinder blocks without necessity of removing them from conveyor. Consists of direct-reading Brinell tester mounted in cylinder that is held in position above the conveyor on four posts. Detroit Testing Machine Co., 5137 Trumbull Ave., Detroit.

Lighting

REFLECTORS—No. 1585 "Jerry" unit for use with 300- or 500-watt Mazda lamp, or with 400-watt high intensity mercury vapor lamp. Aluminum housing. Curtis Lighting, Inc., 1123 West Jackson Blvd., Chicago.

TRANSFORMERS—Transformers and reactors for use with high intensity mercury lights. Two types of mounting: suspension and wall. Two-piece steel case. Westinghouse Electric & Mfg. Co., East Pittsburgh.

Lubricants and Lubricating Devices

GREASES—"Penn Roller" greases for ball and roller bearings. Are said to contain no sulphur or asphalt, only a small amount of grease soap. Marvin Mfg. Co., Chestnut St., Franklin, Pa.

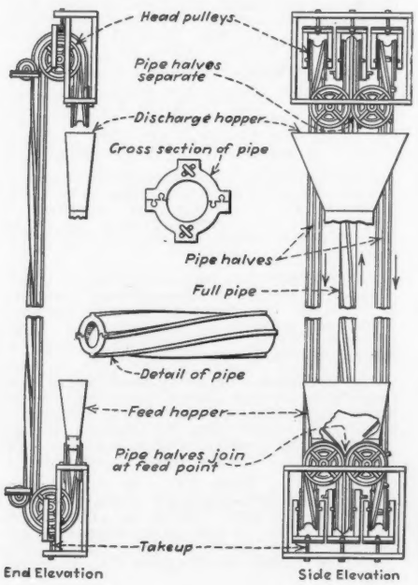
Materials

CALKING MATERIAL — "Caulk-O-Seal." Comes in ⅛-gal. container for insertion into gun. In limestone, gray, white, and natural colors. Calbar Paint & Varnish Co., North Martha St., Philadelphia.

RESINS—For impregnating fabrics, belting, brake lining, and the like. Is said to combine resistance to water, acids, and alkalis with extreme flexibility. General Plastics, Inc., North Tonawanda, N. Y.

Materials Handling

CONVEYOR—New type conveyor consists of two grooved rubber belts running together, forming a moving pipe which will carry wet or dry materials. Moves over pulleys either horizontally or vertically. Special tongue and groove hold two halves together until they are parted for loading or discharging. Johns Conveyor Corp., 605 Broad St., Newark, N. J.



CONVEYOR — Truss-frame, sealed-ball-bearing, belt conveyor carrier. Is 3-roller design with outer rollers inclined at 20 deg. Rollers are made of 5-in. diameter steel tubing. Built in different sizes for belts 18-48 in. wide. Stephens-Adamson Mfg. Co., Aurora, Ill.

CONVEYOR DRIVE—Variable-speed drive for conveyors. In vertical and horizontal types in standard sizes up to 7½ hp. Mounted on heavy steel base and completely covered with heavy steel case. Mechanical Handling Systems Inc., Detroit.

SKID PLATFORMS—Steel lift truck platforms with new corner construction. Said to give greater stability and resiliency. Provides increased resistance to damage by trucks striking sides of loaded platforms. The Youngstown Pressed Steel Co., Warren, Ohio.

TRACTOR—"Huskie" gas-powered tractor. Has 4-cylinder Ford engine and 4-speed truck-type transmission and clutch. Solid or pneumatic tires. Is 96 in. long, has turning radius of 108 in. Develops drawbar pull of 3,000 lb., travels at speeds up to 10 m.p.h. Mercury Mfg. Co., 4110 South Halsted St., Chicago.

TRUCK—Hand truck for handling storage batteries. Top consists of assembly of rollers mounted on 4 wheels which ride on inclines so that batteries may be removed or set down at different levels. Truck has four wheels, two of them in caster mountings. Municipal Supply Co., South Main St., South Bend, Ind.

TRUCK, LIFT—Model A-1002-10 tilting fork truck. Capacity is 4,000 lb. Fork tilts forward 5 deg. and backward 15. It can be raised 52 in. above floor. Gas-electric or battery drive. Hydraulic power used for lifting and tilting. Mercury Mfg. Co., 4110 South Halsted St., Chicago.

Mechanical Power Transmission

BELTS—Two new styles of Condor Compensated Belt. Style F has red friction pulley surface and is designed for use where a slight starting slip is desired. Style B has bareback untreated duck pulley surface and is built for conditions where slip is essential. The Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., 46 Townsend St., Passaic, N. J.

PULLEY — Magnetic pulley. Improved design in which air ducts act with belt to force cooling air around magnet coils. Pulley casting is one piece and is annealed. Stearns Magnetic Mfg. Co., Milwaukee.

PULLEY—"Maxi-Grip" flat-belt pulley for use in exposed locations. Has tapered, herringbone slots. Available in armature pulley of 8-, 9-, and 10-in. diameters, axle pulley in 17-, 18-, and 20-in. diameters, face widths of 10 and 14 in. D. L. Jennings & Co., South Dearborn St., Chicago.

SHAFT — "Watson-Spicer Needle-Bearing Drive." Flexible-drive shaft is said to compensate for angular misalignment up to 20 deg. Transmits up to 250 hp. Can be used for all types of services. H. S. Watson Co., 525 Fourth St., San Francisco.

SHEAVE—"DR" (Demountable Rim Type) sheave. Consists of hub upon which can be mounted rims of varying diameters and number of grooves. Rims can be mounted in four different positions. Dodge Mfg. Corp., Mishawaka, Ind.

VARIABLE SPEED TRANSMISSION — Self-contained unit in compact housing approximately motor size. Furnishes any output speed from half motor speed down to zero and reverse. Range of speed is obtained through single turn of control wheel. Graham Transmissions, Springfield, Vt.

V-BELT COUPLER—"Grip-Flex" roller-bearing coupling in standard sizes from A to E in a variety of types. Anchor plate surrounds belt ends so that no strength is lost. Shippert Mfg Co., Dixon, Ill.

Metal Finishing

FINISHING WHEEL—Fine grit wheel with slight cushion effect. For flat or relatively even curved surfaces. Operating speed maximum is 6,000 surface ft. per min. The Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., 46 Townsend St., Passaic, N. J.

SANDER—Improved No. 6 sanding machine for wood, metal, and composition materials. Center distance between driven and idler drums is adjustable. Work table can be swung clear to change the belt or rotated for angle grinding. Belt is 9 in. wide. Production Machine Co., Greenfield, Mass.

Metal Working

ASSEMBLY PRESS—No. 60 BB 15-ton Greenerd hydraulic press. Is treadle-operated, and especially designed for assembly of ball bearings. Can be adapted for straightening operations. Any pressure from ½ to 15 tons can be obtained on down stroke. Edwin E. Bartlett Co., Nashua, N. H.

CUTOFF MACHINE—No. 37 universal abrasive cutoff machine. Cuts tubing, molding, angles, channels, and hollow shapes of thin metal; also adaptable for glass, porcelain, plastics cutting. Has 1-hp motor, V-belt drive. Whitney Metal Tool Co., 110 Forbes St., Rockford, Ill.

CUTOFF MACHINE—Type F Radiac cutoff machine. Bench model. Cuts solid metal stock up to ¾-in. diameter, metal tubing up to 1¼-in. diameter. Uses abrasive wheel. Steel saw can be attached to cut copper tubing, aluminum, etc. A. P. de Sanno & Son, Inc., McKean St., Philadelphia.

DEGREASING MACHINES — Two. One handles small racked parts which pass through solvent vapors, then pressure sprays of hot clean solvent, and back through vapors. Second is for large stampings and deep drawn parts which are placed in baskets and immersed in boiling solvent, immersed in solvent distillate rinse, then immersed in solvent vapors. Detroit Rex Products Co., Hillview Ave., Detroit.

DRILLING MACHINE — Five-station, drum-type drilling machine with capacity of 55-60 cylinder blocks per hour. It finishes from the rough all valve and tappet holes as well as core drilling the thrust and four water holes. Pushbutton control; electrically interlocked. Bausch Machine Tool Co., Springfield, Mass.

FURNACE—Tempering furnace for tool work. Consists of furnace, Micromax recording controller, control and instrument panels. Furnace is 45 in. high, has 12½x15-in. work space, and operates on 220 volts, single-, 2-, or 3-phase current. Maximum temperatures of 800 or 1,200 deg. F. Leeds & Northrup Co., 4909 Stenton Ave., Philadelphia.

FURNACE, ELECTRIC—Type LFC indirect-arc furnace. Especially designed for high temperature melting of copper, nickel, and alloy irons and steels. Automatic rocking control. Capacity, 350 lb. Detroit Electric Furnace Co., Detroit.

LATHE—Line of toolroom lathes. Has 56 quick feed changes from 0.0013 to 0.166 in. per rev. There are also 56 changes of thread from 1½ to 184 threads per in. Leadscrew and feed rods have separate drives. V-belt drive. R K. LeBlond Machine Tool Co., Cincinnati.

MELTING FURNACE—For melting aluminum, brass, nickel, and iron. By operating handwheel, furnace can be tilted to any angle. Is crucible type with tile lining. Can be gas or oil fired. In 9 sizes, in melting capacities of 130-850 lb., measured in brass. Philadelphia Drying Machinery Co., Stokley St., Philadelphia.

METAL SLUG HEATER—Type CS Berwick electric metal slug heater. Photo-electric cells and automatic kicking-out device control heating of slugs. Jaws have vertical movement. American Car & Foundry Co., 30 Church St., New York.

MILLING MACHINE—Precision bench unit standing less than 2 ft. high, and occupying

bench area of 23x22 in. Travel is 5⅞ in. longitudinally, 3⅞ in. transversely, 5¾ in. vertically. Eight speeds up to 5,000 r.p.m. Hardinge Bros., Inc., Elmira, N. Y.

POINTING MACHINE—Heats and pulls steel bar stock to a point. Two jaws mounted on track at top of machine grip stock while current from 60 kva. transformer is passed through it. When stock is heated to softness, one jaw moves to draw bar to a point. Thomson-Gibb Electric Welding Co., Pleasant St., Lynn, Mass.

PRESS—A 2,000-ton hydraulic press for heavy duty metal forming. Can also be used for pressing and dehydrating various products. Ram is 42 in. in diameter, has 24-in. stroke. Platen surface is 38x64 in. Charles F. Elmes Engineering Works, Morgan & Fulton Sts., Chicago.

PUNCH—High-speed, portable, hydraulic punch for semi-automatic handling of punching operations. Has capacity of 7½ tons. Interchangeable dies for punching holes up to ⅞ in. in sheet steel up to 10 gage. Hannifin Mfg. Co., 621-631 South Kolmar Ave., Chicago.

TUBE BENDERS—Type G16 tube bender for production work. Can bend sixteen 1-in. diameter, 16-gage steel tubes on 4-in. radius or less. Adjustable gages and stop. Interlocking throttle valves so operator and helper can work without injury to either. Williams, White & Co., Moline, Ill

Miscellaneous

BLUEPRINTING MACHINES—Model 27 has radiator-type drier, Model 27-D double-drum ironing-type drier. Either can be had as blueprinting machine only or in combination with washing, developing, and drying equipment. Two sizes accommodating paper either 42 or 54 in. wide. For continuous or cut sheet operation. The C. F. Pease Co., 813 North Franklin St., Chicago.

DRAFTING CURVE—Flexible curve made of rubber, lead, and spring steel. Lead core to give shape-retaining characteristics, spring steel strips to keep slight irregularities in the core from being transmitted to the two drawing edges. Wade Instrument Co., East 118th St., Cleveland.

FIREBRICK JOINTS—"Robinson" joints are box-like casings in which refracted bricks are encased. Joint material is chemically treated asbestos. Said to eliminate checking, cracking, bulging. Five sizes. Continental Engineering Co., Inc., 64 Hamilton St., Paterson, N. J.

INSULATING BEADS—Ball-and-socket design. For wires ranging 0.032 to 1.62 in. White in color. American Lava Corp., Cheroka Blvd., Chattanooga, Tenn.

LABEL PASTER—"Hy-Speed Labelit." A motor drives a label-feed roller and a glue pick-up roller. A pick-up assembly removes labels from the glue roller. It applies glue in predetermined thickness to labels up to 6 in. wide. Alsop Engineering Corp., 39 West 60th St., New York.

LAYOUT TABLE—Improved semi-steel surface plates for accurate layout and inspection work. Are planer finished, smooth, square, and ribbed to prevent sagging. Sizes from 12x18 in. to 48x96 in. Challenge Machinery Co., Grand Haven, Mich.

PHOTOELECTRIC CELL—"Cetron Type CE-20." For use in counting, sorting, grading apparatus. Has 3-prong base, is of caesium-argon type. Continental Electric Co., St. Charles, Ill.

PULVERIZER—"Centriflex" gyratory pulverizer. For crushing and pulverizing all refractory materials. Consists of cone-shaped mantle inclosing cone-shaped muller in center of which is rotating crank. Variety of sizes with diameter of muller ranging 9-60 in. McNally-Pittsburg Mfg. Corp., Pittsburg, Kan.

PUMP—Six-cylinder diaphragm pump for pumping chemicals, abrasives in suspension, acids. Measures 6 ft. in diameter at intake manifold, stands 5 ft. high. Pumping capacity of 270 gal. per min. against 80-ft. head. Cast iron construction; can be supplied with vitrified porcelain or rubber lining. Logan Engineering Co., Ravenswood Ave., Chicago.

RECORD BOOKS AND CABINET—Aluminum book into which record cards are clipped. Edges of books are grooved to ride in rollers in steel cabinet in which books can be stored. Cabinets come in two sizes to accommodate 5 or 10 books. Globe Wernicke Co., Carthage Ave., Cincinnati.

RULE SLIDE—No. 381 slide for use in combination with any one of the company's standard rules. Applied to a Hook rule, it converts it to a caliper rule. Used with a straight rule, it facilitates shoulder-to-flange measurements. Brown & Sharpe Mfg. Co., Providence, R. I.

SEALING DEVICES—Two types of electrically heated plates for sealing packages wrapped in waxed paper or in heat-sealing transparent cellulose sheet. "Seal Plate" unit is mounted on rubber feet. "Flush Plate" can be mounted in work table flush with its surface. Oliver Machinery Co., Grand Rapids, Mich.

TIME STAMP—Improved models. Date is set by moving small wheels at the rear to advance type ribbons. Spring-driven clock. Model S has stem-set clock, Model K key-set. A. D. Joslin Mfg. Co., Manistee, Mich.

TUBE—Flexible tube assembly. Carries steam at 150 lb. pressure. Consists of inner corrugated tube made of bronze in four sections, and fittings with bronze braid extending back along tube, outer galvanized steel armor. Diameter is 2 in., length of assembly 30 ft. Seamlex Co., 5-19 48th Ave., Long Island City, N. Y.

VIBRATION INSULATOR—Type CA-1290. Insert and base plate are molded with rubber into single assembly. Made with various hardnesses of rubber. Equipment can be suspended or supported from below. Firestone Tire & Rubber Co., Akron.

Motors

MOTOR BASE—For fractional-horsepower motors. Motor is carried by rubber in shear, which absorbs vibration. Bodine Electric Co., 2264 West Ohio St., Chicago.

MOTOR BRACKET—Steel, electric-motor end bracket for 300-hp., 1,150-r.p.m., 230-volt, d.c. motor. Fabricated from channel and plate steel with steel plates at each end. Century Electric Co., 1806 Pine St., St. Louis.

Paint and Painting Equipment

PAINTS—Two corrosion-resisting paints, "Causticbond" and "Acidbond," for protection of metal surfaces from caustics and acids. Can be applied over painted or enameled surfaces. Black and white. Wilbur and Williams Co., 402 Park Square Bldg., Boston.

PAINT SOLVENT—For stripping enamel, lacquer, or varnish from metal or wood surfaces. Applied with brush or spray gun. Nielco Products Co., Cicotte Ave., Detroit.

PROTECTIVE COATING—"Nopco Heresite." A liquid coating material for protection of metals against corrosion. Applied by dipping or spraying, it is baked after application. Comes as primer, combination primer and finishing material, or as clear or black coating. National Oil Products Co., Harrison, N. J.

PROTECTIVE COATING — "Protecf-A-Wall." Powdered material is dissolved in water and applied over painted, varnished, or enameled interior surface. Protects finish against grease, smoke, dust. Armiger Chemical Co., Inc., West Austin St., Chicago.

SPRAY GUN CAP—No. 37 for use with company's Type CL gun. For synthetic spray materials requiring high pressure and fine atomization. For pressures 45-75 lb., capacity 8-10 oz. per min. The DeVilbiss Co., Toledo, Ohio.

SPRAY GUN OUTFIT—Pressure cup assembly with regulator and gage. Attaches directly to standard Thor 7 or Thor 2 gun. For materials of such consistency they cannot be sprayed with syphon-feed cup. Binks Mfg. Co., 3114 Carroll Ave., Chicago.

SPRAY MACHINE—Automatic reciprocating spray machine carries Thor Model 7 spray guns back and forth across flat objects moving along conveyor. Guns go on and shut off automatically. Binks Mfg. Co., 3114 Carroll Ave., Chicago.

SPRAY PAINTING EQUIPMENT — "Zephyr." Consists of ¼-hp. electric motor, compressor gun and cup, and air hose. Compressor and motor are mounted integrally. Type R spray gun has parts made of stainless steel and Monel metal. Gast Mfg. Co., Bridgman, Mich.

Paper Making

PUMP—Paper stock pump for supplying stock to paper machine head box. Centrifugal open-impeller type. Allis-Chalmers Mfg. Co., Milwaukee.

TOP PRESS ROLL—"Rub-Roc" top press-roll for top press and smoothing press service. Made of rubber compound, eliminating tendency to adhere to paper sheet. Sheet is instantly released. The Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., 46 Townsend St., Passaic, N. J.

Piping, Valves and Fittings

PIPE CLAMPS — Redesigned clamps for permanently stopping leaks in pipes carrying air, gases, heavy or light liquids. Tested under pressure of 3,000 lb. Applied while lines are in service, except upon extremely high pressure lines. M. B. Skinner Co., 3642 West Sample St., South Bend, Ind.

STEAM TRAP—Combination thermostatic and inverted bucket trap. Removes entrained air when pressures drop to few ounces or fraction of an ounce. Air is bypassed around water seal. V. D. Anderson Co., 1935 West 96th St., Cleveland.

VALVE-POSITION INDICATOR — Model 4-VS Tejax adjustable valve-position indicator. Shows exact setting and permits easy return to that setting. Reads to 1/100 turn. Model 2-VS available for smaller valves. Tefft-Jackson, Inc., Providence, R. I.

Power Plant Equipment

AIR FILTERS—Two types for filtering air to compressor or engine. One has wool-felt filtering unit, other is viscous impingement type. Second has filtering medium made up of continuous strands of galvanized wire. Both units fit into a housing 20 in. square, 6⅜ in. deep. American Air Filter Co., Inc., Louisville, Ky.

BLOWER — Centrifugal blower in two series. One handles air at temperatures up to 900 deg. F., the other handles it up to 1,400 deg. F. This second type is suitable for heat exchanging and furnace heat recirculation. Seven sizes handling from 3,410 to 27,200 cu. ft. per min. General Combustion Corp., West Wacker Drive, Chicago.

BOILER - FEED PUMP — Handles feed water against high or low pressures at high temperature. Can be fitted for automatic operation. Sizes up to 3 in. Becker Pump Co., Inc., Emeryville, Cal., and American District Steam Co., North Tonawanda, N. Y.

CAPACITORS — Redesigned box-type "Power Factor Correction Capacitors." Can be mounted on ceiling, wall, or floor in single units or compact groups up to 100 kva. Cornell-Dubilier Corp., South Plainfield, N. J.

COMPRESSORS—Improved line of single, horizontal, 3-stage compressors for pressures of 750-2,500 lb. Suitable for air, oxygen, hydrogen, refinery or natural gas. Steam or motor drive. Worthington Pump and Machinery Corp., Harrison, N. J.

CONDENSER—Type HP-504-2 heavy duty condenser for air lines. Removes oil and water by baffle arrangement and pair of filter pads which can be replaced without disconnecting condenser from the line. The DeVilbiss Co., Toledo, Ohio.

DIESEL — Type KD. Is cold-starting mechanical-injection engine which can rotate in either direction. Rated at 1,000-ft. altitude, 257 r.p.m. to suit direct-connected generators. Two flywheels for driving belts. Anderson Engine & Foundry Co., Anderson, Ind.

NEW Equipment · Machinery · Materials · Supplies

FILTER — "Flo-Klean" liquid filter for clarifying coolants, water, and other liquids. For use singly or in multiple. Threads of wire are wound to provide filtering spaces 0.001 to 0.020 in. wide. Continuous cleaning by backwash nozzles and scrapers. Cuno Engineering Corp., Meriden, Conn.

FUEL METER—"Mir-O-Meter." Measures, indicates, and records amount of oil delivered to furnace. Displacement rotor is revolved by fuel and operates tachometer generator which generates electrical force actuating indicator dial. S. F. Bowser & Co., Inc., Fort Wayne, Ind.

GENERATOR — "No-Bat, Hydro-Gas-Electric" generator driven by internal combustion engine. Engine can be driven by gasoline or gas. For a.c. or d.c. current or combination of the two. Also has water motor belted or geared to the engine, and combination water pump and compressor. Bryan Engineering Co., Williamsport, Pa.

GENERATOR—Two sizes, driven by single-cylinder, 4-cycle gasoline engine. One size rated at 2 kw., other at 3, 115 volts d.c. Automatic voltage regulation. Moon Mfg. Co., North Jefferson St., Chicago.

TURBINE—Type C impulse-type turbine having one pressure and two velocity stages. Capacities ranging 5-500 hp. at speeds of 1,000 to 5,000 r.p.m. For steam pressures up to 650 lb. gage and temperatures up to 750 deg. F. Westinghouse Electric & Mfg. Co., East Pittsburgh.

WATER COOLING SYSTEM — Line of jacket watercoolers. Two models in eight sizes. Designed to cool gasoline or diesel engines from 29 to 122 hp. Units are self-contained and include cooling coil, fan, drive shears, pump. Young Radiator Co., Racine, Wis.

Printing

BLOCK LEVELLER — No. 4 simplified block leveller for precision planing of mounted plates. Work is revolved while end milling operation is performed on it. Levels both wood and metal mounted plates. Micrometer height adjustment. Hacker Mfg. Co., South Honore St., Chicago.

REGISTER TABLE — "National Register Table." With it forms can be placed in exact alignment before going to press, with saving in register and line-up costs. Southworth Machine Co., Portland, Me.

ROUTERS—Three redesigned models of routers and router planers, R-2, No. 11, and No. 7. All have high-speed motors, ½ hp. for R-2 and No. 11, ¼ hp. for No. 7. Hammond Machinery Builders, Inc., Kalamazoo, Ind.

Refrigeration

REFRIGERATING MACHINE—Improved design of double-compressor refrigerating machine with cooling coils assembled in cylinders below the base Has 20-hp. motor for 3-phase, 60-cycle, 440-volt operation. Curtis Mfg. Co., Kienlen Ave., St. Louis.

Safety Equipment

LIFE LINE ADJUSTOR — "Allsafe Life Line Grab." Automatic adjustor eliminates human failure to adjust slack in life line. Line travels freely through the "Grab" as workman moves about. Should he fall, it snubs the line, holding him by his safety belt. American Allsafe Co., Inc., 210 Franklin St., Buffalo, N. Y.

RESPIRATOR—Bulb Valve Type No. 24 Dupor respirator. Has two large offset filter plates into which replaceable filter pads fit. Pads are 4⅝ in. in diameter. Without pads respirator weighs only 4 oz. H. S. Cover, Station A, South Bend, Ind.

RESPIRATOR—Type MPH hood respirator for use where there is an extraordinary fume or dust hazard. Light-weight, sanitary flame-proofed hood supported by a light-weight respirator covers head and shoulders fully. Air flows through hood and out vision opening, providing clear vision without glass. The DeVilbiss Co., Toledo, Ohio.

Textile

CLEANING SYSTEM — Automatically cleans lint from textile machinery Consists of blower suspended on a carrier from a MonoRail track. A ⅛-hp. motor propels the unit. Volume of air can be controlled. American MonoRail Co., Athens Ave., Cleveland.

HOSIERY INSPECTION FORMS — Gloss black molded forms with steel reinforcing. Complete with flange ready to bolt to an inspection stand. Made of Micarta; retain surface and color. Westinghouse Electric & Mfg. Co., East Pittsburgh.

STIFFNESS TESTER—Measures stiffness, softness, pliability of wide range of fabrics from voiles to denims. Consists of balanced pointer, upon which various weights can be loaded, which indicates bending resistance of sample. W. & L. E. Gurley, Troy, N. Y.

Tools and Supplies

BLOW TORCH—For thawing frozen pipelines, heating, burning. Burns gasoline. Cylinder of seamless brass tubing. Cast-bronze ends are brazed in place. Length is 41 in. Turner Brass Works, Sycamore, Ill.

COIL WINDING HEAD—"Concentric Coil Winding Head." Winds single-phase motor coils in gangs or groups up to six in a nest in all sizes and shapes. Adjustable for length and width of coil. Ideal Commutator Dresser Co., 1416 Park Ave., Sycamore, Ill.

COMMUTATOR SLOTTER — Swiveled, hand-type slotter and scraper for commutators. Can be used for cleaning slots or for beveling the sharp edge of the copper after undercutting. Faces of swiveled head have interlocking notches. Ideal Commutator Dresser Co., 1416 Park Ave., Sycamore, Ill.

DRUM OPENER—No. 565 all-purpose steel drum opener. Made of malleable iron with black japan finish. Claimed to be able to perform variety of operations on different types of drums. Richards-Wilcox Mfg. Co., Aurora, Ill.

GASKET—Consists of hermetically sealed ring containing non-explosive gas under pressure. Can be supplied in wide variety of metals, shapes, and sizes. Wills Gasket, Ltd., New Bedford, Mass.

GASKET CUTTER—Will cut gaskets 1 to 36 in. in diameter from a variety of materials. Can be adjusted for any thickness from 1/100 to ⅝ in. Furnished with six double-edged cutting blades. Allpax Co., Inc., Mamaroneck, N. Y.

HAMMERS—Soft-face hammer for work on fine finished surfaces. Tips are of tough composition material which, it is said, will not shatter, chip, or break. Tips can be replaced. Three sizes. Bonney Forge & Tool Works, Allentown, Pa.

LOCKS—"Sesamee Padlocks." Have four number wheels on bottom. After wheels have been turned to correct opening number, you simply push up on hardened steel shackles to open the lock. The Sesamee Co., 133 Laurel St., Hartford, Conn.

PACKING—For rod packing in deep or shallow stuffing boxes. Consists of adjoining rings with bottom V-shaped ring, top grooved ring, intermediate rings on which are projections that hold rings slightly apart until pressure forces them into a sealing position. Sterling Asbestos & Rubber Co., Grand Central Terminal, New York.

PIPE DIEHEADS—A 10 in. stationary pipe diehead with capacity of 4 to 10 in. Manually operated and locked when closed. Universal adjustment for size. Landis Machine Co., Inc., Waynesboro, Pa.

RACHET—No. 60-R pipe threading ratchet. Range ¼ to 1¼ in. Has 3-jaw self-centering chuck. Made of malleable iron. Beaver Pipe Tools, Inc., Warren, Ohio.

ROD STRAIGHTENER — Improved rod straightener and shear machine for reclaiming rod, bolts, wire, and nails. Ranges in size from small hand-operated model with capacity of ¼-in. rods to compressed air unit with capacity of 2½-in. rods. The American Foundry Equipment Co., 555 South Byrkit St., Mishawaka, Ind.

SOLDERING IRON — No. 900. Suitable for heavy work. Has electric heating element of 700-watt rating. Copper tip, tinned at the point, is 1⅝ in. in diameter. Vulcan Electric Co., Broad St., Lynn, Mass.

SPRAY GUN OUTFIT—Thor 3SD gun outfit for heavy materials, especially sound deadeners. Nozzle gives round spray. Requires 5 to 9 cu. ft. of air per min. at 30 to 60 lb. pressure. Two-qt. cup or 2-gal. pressure tank. Binks Mfg. Co., 3114 Carroll Ave., Chicago.

STEEL TAPE—"Wyteface" steel measuring tape. Coated in permanent white with black graduations. Manufacturer claims surface will not crack or chip, surface will not corrode. Black leather case. Keuffel and Esser Co., Hoboken, N. J.

WRENCHES — Two lines of adjustable wrenches. Both have square shoulders on movable jaw shank and thicker and stronger web "Adjustable" is drop forged from carbon steel. "Superjustable" is forged from chrome alloy steel. J. H. Williams & Co., 75 Spring St., New York.

Welding and Cutting

CUTTING MACHINE — Portable flame-cutting machine. Mounts on templet table and follows templet in cutting straight lines or curves. Can be guided by hand or made to operate automatically. Operates in area 30x60 in. without moving machine or the work. General Welding & Equipment Co., Cambridge, Mass.

WELDER — "Giant Grip Junior" a.c. welder. Four models in capacities 90-300 amp. Specially designed transformer type. Rotating knife switch control with amperage indicated at each step. Giant Grip Mfg. Co., Oshkosh, Wis.

WELDER—"King Type W-1." Has high-reactance transformer mounted inside of cabinet which is mounted on casters and has steel table top where work may be handled. Eight steps between 30-150 amp. in transformer setting. Capacity 20-gage to ⅜-in. metal. Electric Heat Control Co., Inman Ave., Cleveland.

WELDERS — New line of P&H Hansen "Smootharc" welders featuring single current control, self-excitation, and internal stabilization. Vertical model in capacities of 75, 100, and 150 amp.; horizontal, 200, 300, 400, and 600 amp. Harnischfeger Corp., 4525 West National Ave., Milwaukee.

WELDERS—"Speedarc" portable arc welders. Dual control. In 125, 200, 300, 400-amp. sizes. Is said to have short recovery time from short circuit to normal welding current, and low short-circuit current surge. Ideal Electric & Mfg. Co., Mansfield, Ohio.

WELDING MACHINE — Automatic, remote-control welding machine using standard coated rods at uniform high speeds. Work table starts and stops automatically as new electrodes are brought into action. Up to 50 rods can be loaded at a time. Harnischfeger Corp., 4525 West National Ave., Milwaukee.

WELD TESTER—Hydraulic machine tests strength of spot welds. Will test up to 10,000 lb. Has 8-in. precision dial. Pump is operated by ¼-hp. motor. Portable. Baldwin-Southwark Corp., Philadelphia.

Wire and Wiring Devices

CABLE CONNECTOR—"Wesco Grip-Tite Connector." Natural seating and automatic locking effect regardless of cable surface irregularities are claimed. Made of malleable iron in ⅜-in. size. Westinghouse Electric Supply Co., Inc., 150 Varick St., New York

CONNECTOR — Split-bolt connector with nut-retaining feature. Retainer holds contact pad and nut out of the way while wires are inserted and is pushed flat against connector when nut is tightened. Eight sizes for wires from No. 8 to No. 4/0. Line Material Co., Milwaukee.

FUSE CUTOUTS—Secondary fuse cutouts for attachment to line wires by means of standard bolt connectors. Two styles: "Ten-

sion" type has loop for connector attachment, "Service" type has no terminal at bottom end of arcing tube. For 100-amp. fuses on voltages up to 600. Line Material Co., Milwaukee.

WIRING UNITS — Pre-assembled wiring devices mounted on plastic outlet box covers for use with standard 4-in. outlet boxes. Single-pole and 3-point tumbler switches, duplex convenience outlets, porcelain lamp holders. The Bryant Electric Co., Bridgeport, Conn.

Woodworking

PLANERS—Nos. 95 and 96 single planers. In widths of 24, 30, 36, 40, and 44 in. Power to drive feed is taken from cutterhead motor by belting to a clutch pulley mounted on feed shaft. Any speed may be selected without stopping motor. Baxter D. Whitney & Son, Inc., Winchendon, Mass.

•

TRADE LITERATURE

Abrasives—Folder, on steel abrasives for blast cleaning work.—Pangborn Corp., Hagerstown, Md.

Air Compressors—Bulletin L-611-B2A, on line of air compressors.—Worthington Pump and Machinery Corp., Harrison, N. J.

Alloy Steel—Bulletin F-1, title "The Making and Shaping of Alloy Constructional Steels."—The International Nickel Co., Inc., 67 Wall St., New York.

Belt Lacing—Folder, on leather belt lacings.—J. E. Rhoads & Sons, 35 North Sixth St., Philadelphia.

Boiler Water Treatment—Bulletin No. 500, title "The Inside Story of Boiler Water Conditioning."—Elgin Softener Corp., Elgin, Ill.

Connectors—Booklet, on rolled and drawn seamless connectors for splicing wire and cable.—Anaconda Wire and Cable Co., 25 Broadway, New York.

Carbide Tools — Price List, on Carboloy standard tools and blanks.—Carboloy Co., Inc., 2999 East Jefferson Ave., Detroit.

Communicating System—Bulletin No. 440, on Lokator interoffice communicating system. —Edwards and Co., Inc., 140th and Exterior Sts., New York.

Cranes—Bulletin 102, on line of cranes for overhead conveying systems.—The Louden Machinery Co., Fairfield, Iowa.

Cranes—Folder No. 506, on hand- and electric-powered cranes.—Lewis-Shepard Co., 175 Walnut St., Watertown, Mass.

Degreasing—Three bulletins, describing equipment and processes for solvent degreasing.—Detroit Rex Products Co., 13005 Hillview Ave., Detroit.

Diesel Engines—Bulletin, on Type EN diesel engines of 3, 4, 6, and 8 cylinders.—The Cooper-Bessemer Corp., Mt. Vernon, Ohio.

Doors—Catalog, on line of rolling doors.—Cornell Iron Works, Inc., 3600 13th St., Long Island City, N. Y.

Furnace Construction — Bulletin No. 101, on supported furnace wall construction.—Geo. P. Reintjes Co., Kansas City, Mo.

Gears—Catalog G, on double helical gears for steam turbine drives.—De Laval Steam Turbine Co., Trenton, N. J.

Grinders—Bulletin No. 47, on line of pedestal and bench grinders.—Baldor Electric Co., 4357 Duncan Ave., St. Louis.

Heating Units—Leaflet TC-30, on electric cartridge and tubular heating units.—Harold E. Trent Co., 618-640 North 54th St., Philadelphia.

Life Line Safety Catch—Folder, announcing Allsafe Life Line Grab.—American Allsafe Co., Inc., 210 Franklin St., Buffalo, N. Y.

Lighting—Brochure, giving the story of indirect lighting in industry. Illustrated.—Silvray Lighting, Inc., Nelson Ave. and School St., Long Island City, N. Y.

Materials Handling—Catalog No. 500, covering line of trucks, skids, elevators, racks. Illustrations of installations. — Barrett-Cravens Co., 3255 West 30th St., Chicago.

Materials Handling—Catalog, on line of materials handling equipment.—Gifford-Wood Co., Hudson, N. Y.

Oil Extractor—Folder, on centrifugal oil extractor for recovery of cutting oils.—National Separator Co., Worcester, Mass.

Oilers—Circular, on Opto-Matic and Drip-Drop oilers.—Trico Fuse Mfg. Co., Dept. C, Milwaukee.

Paint—Booklet, on Luminall, a paste casein paint.—National Chemical & Mfg. Co., Inc., 3617 South Wall St., Chicago.

Pipe Clamp—Folder, announcing emergency pipe clamp. M. B. Skinner Co., South Bend, Ind.

Plastic — Booklet, illustrating industrial applications of Micarta.—Westinghouse Electric & Mfg. Co., East Pittsburgh.

Pneumatic Products—Catalog No. 200, on line of products for compressed air applications.—C. A. Norgren Co., Inc., Denver, Col.

Power Plant Instruments—Broadside 160, describing power plant measuring instruments and controls.—Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia.

Presses—Bulletin 64-E, on line of double crank presses.—Niagara Machine & Tool Works, 637-697 Northland Ave., Buffalo, N. Y.

Pumps — Bulletin 5550, describing built-together pumps.—Fairbanks, Morse & Co., 900 South Wabash Ave., Chicago.

Pumps—Bulletin No. 7066, covering line of Coupled pumps.—Ingersoll-Rand Co., 11 Broadway, New York.

Pumps—Bulletin W-323-B1A, on automatically primed centrifugal pumps.—Worthington Pump and Machinery Corp., Harrison, N. J.

Respirator—Folder, describing Dupor plate respirator for protection against dust.—H. S. Cover, Station A, South Bend, Ind.

Riveters — Bulletin 39, describing "Hy-Power" hydraulic riveters.—Hannifin Mfg. Co., 621-631 South Kolmar Ave., Chicago.

Roofs—Booklet, title "Things You Should Know About Your Roof."—Johns-Manville Corp., 22 East 40th St., New York.

Separator—Bulletin 39A, on Counter-Current Classifiers for separating coarse from fine particles.—Hardinge Co., York, Pa.

Stainless Steel—Series of five booklets on Enduro stainless steels: First is general; second on 4-6 per cent chromium steels; third on types AA, FC, S, and S-1; fourth on types HCN, NC-3, and HC; fifth on 18-8 types.—Republic Steel Corp., Cleveland.

Steel Strapping—Booklet, illustrating ways of handling products on platforms, using steel strapping to secure them.—Acme Steel Co., 2840 Archer Ave., Chicago.

Stokers—Book No. 1619, on automatic coal stokers for capacities up to 300 hp.—Link-Belt Co., 2410 West 18th St., Chicago.

Synchronous Motors—Bulletin 1154A, on synchronous motors, coupled and engine types.—Allis-Chalmers Mfg. Co., Milwaukee.

Temperature Controls—Catalog 36, on temperature controls and thermal relays.—Thomas A. Edison, Inc., West Orange, N. J.

Thermometers and Gages—Catalog No. 6703, on line of thermometers and pressure gages.—The Brown Instrument Co., Wayne and Roberts Aves., Philadelphia.

Tractor—Bulletin 205, announcing four-wheel model Huskie gas tractor.—Mercury Mfg. Co., 4118 South Halsted St., Chicago.

Trucks—Bulletin, describing high-lift platform trucks.—The Elwell-Parker Electric Co., Cleveland.

Trucks—Folder No. 225, covering line of floor trucks.—Lewis-Shepard Co., 175 Walnut St., Watertown, Mass.

Unit Conditioner — Folder, describing Vigor-Aire unit air conditioner.—Vigor-Aire Corp., 127 South Fifth St., Philadelphia.

Variable Speed Transmission—Bulletin No. 302, describing Graham variable speed transmission.—Graham Transmissions, Springfield, Vt.

Water Softener—Publication 2059, on hot process water softener of deaerating type.—Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia.

Welder—Bulletin No. 412, on "Shield-Arc S.A.E." welder.—The Lincoln Electric Co., Cleveland.

Welding—Pamphlet, title "Lower Piping Costs with Shielded Arc Welding."—The Lincoln Electric Co., Cleveland.

Wheel Dresser—Catalog DR-36, describing diamond-impregnated carbide wheel dresser. —Carboloy Co., Inc., 2999 East Jefferson Ave., Detroit.

Wire and Cable—Handbook, of wire and cables for all conditions.—Anaconda Wire and Cable Co., 25 Broadway, New York.

•

BOOKS

PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE

The Lincoln Electric Co., Cleveland Ohio. 819 pages, index. Illustrated. $1.50.

Fourth edition—revised and enlarged. Includes most recent data on arc welding, with 223 pages and 289 illustrations added since the third edition. Eight sections of the book cover welding methods and equipment; technique of welding; procedures, speeds, and costs for welding mild steel; structure and properties of weld metal; weldability of metals; designing for arc welded steel construction of machinery; designing for arc welded structures; typical application of arc welding in manufacturing, construction, and maintenance.

MECHANICAL POWER TRANSMISSION HANDBOOK

William Staniar, Mechanical Power Engineer, E. I. duPont de Nemours & Co. McGraw-Hill Book Co., Inc., 330 West 42d St., New York. 488 pages, index. Illustrated. $5.

This comprehensive handbook covers all phases of mechanical power transmission. Furnishes definite, concise information to plant superintendents, maintenance men, designers, and sales engineers on the proper selection and application of equipment. Among the things treated in its fifteen chapters are belting, shafting, bearings, couplings, chain drives, variable speed control, gear reduction units, lubrication, motors, short-center driving methods, and high-starting-torque devices.

•

ON THE CALENDAR

DECEMBER

7–10, National Association of Manufacturers, Annual Congress of American Industry, December 7 and 8; Annual Meeting, December 9 and 10; New York. Noel Sargent, Secretary, 11 West 42d St., New York.

28–Jan. 2, American Association for the Advancement of Science, Winter Meeting, Atlantic City, N. J. Henry B. Ward, Permanent Secretary, Smithsonian Institution Building, Washington, D. C.

JANUARY

7–11, American Engineering Council, Annual Meeting, Washington, D. C. F. M. Feiker, Secretary, 744 Jackson Place, Washington, D. C.

11–15, Society of Automotive Engineers, Annual Meeting, Detroit. John A. C. Warner, Secretary, 29 West 39th St., New York.

25–27, American Society of Heating and Ventilating Engineers, Semi-annual Meeting, Swampscott, Mass. A. V. Hutchinson, Secretary, 51 Madison Ave., New York.

25–29, American Institute of Electrical Engineers, Winter Convention, New York. H. H. Henline, Secretary, 33 West 39th St., New York.

FEBRUARY

14–19, National Electrical Manufacturers Association, Mid-winter Meeting, New York. W. J. Donald, Managing Director, 155 East 44th St., New York.

What IS High Cycle Anyway?

HERE'S THE ANSWER

A As applied to your daily production problems, High Cycle is the adaption of 180-cycle current to portable electric tools, giving them several distinct advantages over Universal-Motored tools on production work.

Q What are the advantages of high cycle tools?

A There are three which you will quickly recognize: 1. Less weight per unit of power; that means less operator fatigue. 2. Speed maintained under load; that means better work and faster production schedules. 3. Induction type motors; that means less "time out" for repairs and lower maintenance cost per tool.

Q To what extent do high cycle tools maintain speed under load?

A The High Cycle Motor registers only a 20% decrease in speed between no-load and stall points, instead of the steady decrease up to 60% usually registered by a Universal Motor. This is particularly important on abrasive tools like sanders and grinders, because a decrease in the speed of the tool results in an additional decrease in the grinding efficiency of the abrasive and a corresponding increase in the time necessary to complete the operation.

Q Why and how do high cycle tools reduce production Costs?

A Delivering more power per pound of weight, and maintaining constant speed under load, High Cycle Tools enable the operator to turn out more work, in less time, with less fatigue. Savings in costs—amounting to as much as 25%, 30% or 35% per operation—are not unusual when High Cycle Tools replace Universal Tools on the production line.

Q How do high cycle tools reduce "time out" for repairs?

A The High Cycle Motor has no commutator, brushes, armature windings, or other electrical connections between the rotor and stator—thereby eliminating the causes of 80% of the breakdowns and repair "recesses" usual with Universal Tools.

Q What types of plants should install high cycle tools?

A Experience has shown that almost any plant which uses ten or more Universal or Compressed Air Tools for production work can effect important savings by replacing them with High Cycle Tools. In some cases, worth-while economies have been effected by replacing only one or two Universal or Compressed Air Tools with High Cycle Tools.

Q From what source is high cycle current available?

A The necessary 3-phase, 180-cycle current is easily obtained by installing a frequency changer or a motor generator set.

Q What tools are available for use with high cycle current?

A Most types of the famous Black & Decker Universal Tools, which have been extensively used in industry for years, also are available with High Cycle Motors. The Black & Decker High Cycle line includes Drills, Reamers, Screw Drivers, Nut Runners, Tappers, Stud Setters, Portable Sanders, Portable Grinders and Die Grinders.

Q How can I find out whether high cycle tools will reduce my costs?

A Black & Decker's High Cycle Engineers will be glad to make a study of your production operations and give you a report on the economies which can be effected through the use of High Cycle, without cost or obligation on your part. For further information and catalog, write to: Black & Decker-Van Dorn, High Cycle Division, 719 Pennsylvania Ave., Towson, Md.

BLACK & DECKER -VAN DORN High Cycle TOOLS

Made by the World's Largest Manufacturers of Portable Electric Tools

Questions & Answers

CONDUCTED BY

G. A. Van Brunt

Production and Shipping Order System

We have to set up a production and shipping order system covering the manufacture and shipment of abrasive wheels. A few items are made for stock, but most of the wheels are manufactured on customers' orders and specifications. They vary in size from small wheels 1 in. in diameter and 1/16 in. thick to large ones 36 in. in diameter and several inches thick.

Quantities on any order range from one wheel to several hundreds, sometimes a few thousands, although the majority of orders call for small quantities and can be made up in three or four days. When sales are heavy many changes would be needed in any set-up of a control board or sheet. The management has also expressed disapproval of a master copy system, because of that fact. Now we use one form which travels through the plant with the material, after it has been put into production.

There is also difficulty in the oven department with large orders. When a group or lot of wheels is formed and pressed, they are delivered to the ovens in molds. A job ticket giving their serial number accompanies the wheels. That brings up another complication—each wheel is given a serial number which we must keep track of, in order to trace down any complaints that may be received later. Since the wheels are incased in molds we know only the numbers of those in the group, but cannot always put them through the ovens in one lot. Therefore, the lot becomes broken up and we cannot tell which heat a given wheel was cured in. This is important since the oven cures vary.

Operations in the manufacture of wheels are: (1) Mix; (2) form; (3) press; (4) oven; (5) finish and face on lathes; (6) inspect; (7) pack and ship.

ONE important question is whether the order of processes and relative time taken at each process are approximately standard for all types of orders. That is, are the operations always performed in the same order, and do mixing, pressing, ovening, and so on consume relatively about the same time per wheel.

Assuming that this is approximately true, it would seem as though you should be able to make use of some very simple and effective scheme known as the block system. In this plan small orders are grouped into blocks. A block represents, say, an hour's capacity of the entire plant, assuming that the various processes are approximately balanced in their time requirements. The size of the block may be varied to fit conditions anywhere from 15 min., in the mail order business, to a day, in other instances. Whatever the time interval of the block, it should represent an hour's work or a half day's work, depending on the general capacity of the shop, based on the number of wheels, the tonnage, or any other factor that may apply.

As each block is started the foreman is furnished with a list of the

The Inland 4-Way pattern with projections centering one another at right angles gives 4-Way traction for feet and wheels. It matches four ways—drains and sweeps clean four ways. The projections overlap reinforcing one another giving extra stiffness and strength.

Made with three different size projections in a full range of widths and thicknesses. Write for complete data.

Joseph T. Ryerson & Son, Inc., Chicago, Milwaukee, Cleveland, Cincinnati, Detroit, Boston, Buffalo, St. Louis, Philadelphia, Jersey City

RYERSON

Ryerson stocks also include everything in steel and allied lines.

BEAMS AND HEAVY STRUCTURALS
CHANNELS, ANGLES, TEES AND ZEES
RAILS, SPLICES, SPIKES, BOLTS, ETC.
PLATES—SHEETS
STRIP STEEL, FLAT WIRE
STAINLESS STEEL
HOT ROLLED BARS—HOOPS AND BANDS
COLD FINISHED SHAFTING SCREW STOCK
COLD FINISHED FLATS
ALLOY STEELS—TOOL STEELS
HEAT TREATED ALLOY STEEL BARS
BOILER TUBES AND FITTINGS
WELDING ROD—MECHANICAL TUBING
RIVETS, BOLTS, NUTS, WASHERS, ETC.
REINFORCING BARS
BABBITT METAL AND SOLDER

individual orders included in the block. He crosses these off as they are completed and delivered to the next department which may also, if desired, sign for them. Whether or not this is done depends on the need for fixed follow-up and placing of responsibility. In general, it is advisable to check the blocks in. The record of completed blocks is sent to the office. No block is cleared until all the orders in it and in all previous blocks have been cleared.

This procedure puts pressure on each foreman to clean up his work as he goes along, and results in a very simple and dependable control of the work.

Whether the block system will work in any given case depends largely on the ability to estimate the time required. On the other hand, the time estimate does not have to be exact. If the shop is given sufficient time it will usually get ahead of its schedule on blocks, or can run slightly behind without creating difficulty. The one essential condition is that the work shall be approximately balanced from department to department.

Then Try a Planning Board

If this system is not applicable, and if the number of orders handled per day is beyond the limits of practicable personal supervision, you will probably be forced to use something like the Taylor planning board. In this plan a board with a clip for each machine is kept in the shop office, or by each foreman. The orders for the machine are arranged in order under this clip. Details of this and a number of other plans were given in the special section on production control, published in our June, 1935, issue.

A follow-up man checks all orders through a progress record and makes sure that they are clear, exercising meanwhile a control, with the superintendent or schedule clerk, on the order in which the jobs shall be done. This plan would require writing a ticket for each operation, as the work is usually handled. It would, however, probably save time as compared with the present cumbersome scheme of looking up the material in the shop.

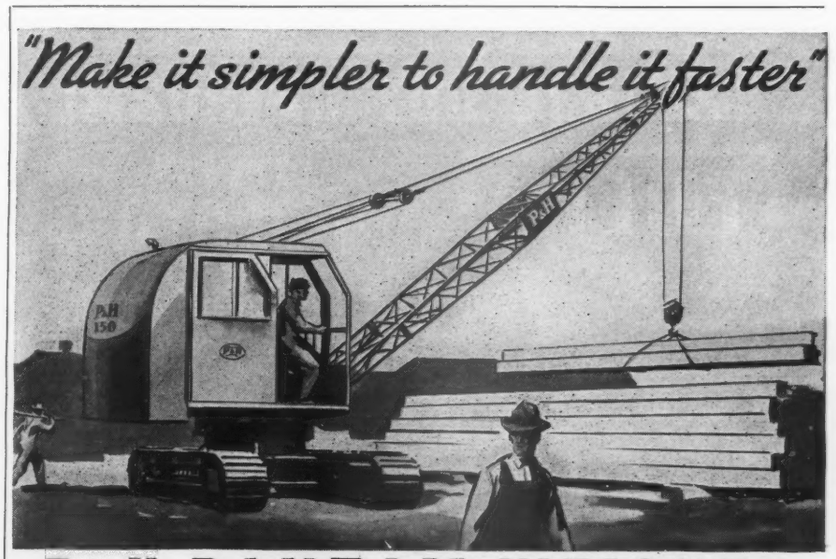
The difficulty with large lots can probably be overcome only by more complete identification of the lots before they go into the oven. If the molds were numbered with chalk that would not burn off it should be possible to run more than one lot in a heat without confusion. Where the lot has to be split, if you have ovens of varying capacity, it should be possible to arrange it so that on large orders only one charge goes into the oven at a time. If more than one charge is necessary, each would belong to the same lot. Then the problem of uniformity will simply be that of controlling oven conditions so that they do not vary with different lots.

In other words, lots up to the capacity of the oven should all go in at one heat. If they exceed the capacity of the oven, temperatures should be controlled to secure the required uniformity. —EDITOR

ANSWERS WANTED

Operating Six Transformers in Parallel

We have three 50-*kva. and three* 25-*kva. transformers rated at* 460 *volts primary and* 230/115 *volts secondary. They are all of the same polarity. Will someone please tell me whether it is possible, and if so, how, to parallel these transformers in order to balance the load on the three-phase feeders and equalize the load on the transformers, which will supply* 115-*volt lighting circuits? —G. H. P.*



P&H BANTAM WEIGHTS

FOR ALL SORTS OF "Outside" Handling Jobs

● There are no restrictions as to when, where or what sort of materials you handle with this fast crane mounted on any light truck chassis. Anything from sand to structural steel you can pick up around the plant with clamshell or hook; or you can take it around town at truck speed on special work. It's simpler to use, handles more jobs—that's why it's always busy. Its moderate price means a lower investment in handling equipment for you. A post card is the easy way to get the facts. Ask for bulletin TM-1.

HARNISCHFEGER CORPORATION
4525 West National Avenue, Milwaukee, Wis.

P&H CRAWLER-TRUCK & "SWITCHER" CRANES

Striking Against Strikes

(Continued from page 38)

ganized group the union so strengthened itself that the management had no choice but to accept the best and fairest terms that we could agree upon. As a result there is little likelihood of another strike in the plant in the near future.

Strike C was a prolonged affair that started simply enough as an ordinary dispute between a majority union and the company over working conditions, wages, union recognition, and seniority rights. Before it was settled other elements had been injected; five persons had been fined and given suspended jail sentences for violence growing out of the strike; and the company and the union, which previously had been reasonably friendly in their relations, exhibited every evidence of bitter enmity.

There seemed to be no apparent reason at first why the dispute could not be settled quickly, but violence started and the company became firm in its determination to yield nothing. Consequently the union became more insistent.

Injunction proceedings were brought by the company, starting a long parade of witnesses through the courtroom. Meanwhile production was at a standstill. Employees did not draw their pay.

Finally the judge who was hearing the injunction case called my office and asked if something could not be done. There appeared to be no end to the testimony that might be introduced; every day the matter continued in court just added so much more fuel to the growing enmity and mistrust.

Within a day the two sides had met at my office, first separately and then jointly, and out of those conferences came an agreement. Talking to both sides it was apparent that the dispute could have been settled before the strike was called or at least within a day or two after the men walked out. The losses to both sides were needless.

Practical Solutions Needed

Problems of employer-employee relationships are practical problems for which practical solutions must be found. It should not be difficult for the average employer to determine what conditions of work particularly irk the employees. It is difficult to imagine workers rebuffing efforts by employers to ascertain and adjust those things, most of them comparatively minor, although they often lead to industrial disorder. Sincere efforts to take care of grievances make for confidence, and few workers will turn on the management in which they have complete trust and confidence.

Sometimes the bothersome problems are very apparent to the management, but efforts to adjust them fail for one reason or another. To help in the solution of such problems the government has established agencies throughout the country, and employers and employees are free to seek the advice of experienced labor relations men.

If their hands are clean and they sincerely desire to be fair, there is no reason why employers and employees should not call on government mediators to help adjust the many and varied labor problems that arise. Almost no strike is absolutely necessary. Almost every strike could be prevented. Reasonable attitudes on the parts of labor and management, plus the help of those whose job it is to adjust industrial disputes, could make strikes most uncommon.

FEDERAL
DIAL INDICATORS
Putting Speed and Greater Accuracy in Inspection
Motion and time study men as well as chief inspectors will be interested to learn of the many new ways in which dial indicators are being used to hold production to standards. They eliminate human variations and save time and money in assembly. Let us cooperate on your work. There is no obligation.
Send for Bulletin No. 41
FEDERAL PRODUCTS CORPORATION
1144 EDDY ST. PROVIDENCE, R. I.
Have a Wide Number of Uses
Check depth, stretch, density, compressibility, vibration, size, thickness, etc., etc.
Have Many Features
Federal offers more models of Dial Indicators and Dial Gauges, exceptional accuracy and durability.

Fifteen Months More of Paying by the Year

(Continued from page 44)

one under straight time, the other for the excess production. The attitude was, of course, that all of the increase was due to the exertions of the workers. When the management had pointed out that a fair adjustment must take into account the company's contribution to greater output, the representatives of the workers inclined to hold out for their original request.

It was shown that if the management had been figuring a labor budget for 7,000,000 pounds of production, the budget would not have been set 40 per cent higher than for 5,000,000 pounds because certain positions would not have had to be increased at all. Finally, the representatives agreed that it would be entirely fair to give the workers of the gang the pay of the extra men who would have had to be paid to turn out this much production if it had been originally planned. Then the company added an extra week's pay for good measure. And everybody was satisfied.

In last year's article it was pointed out that the shortage of hogs arising from the 1934 drought and AAA curtailment of farm production had made necessary a provision to take care of this decrease in pork production. The company agreed for 1935 to continue the hog killing and cutting gangs at the same straight-time rates as before, in consideration of the men agreeing to make up any production shortage by 1939. In 1936, with hog supplies somewhat increased but still short of the normal 1,000,000 per year, this agreement was continued. The management expects that the men will measure fully up to the standards of fairness, and will meet their obligation without any difficulty. It is recognized that this will be easier all around if the supply of hogs increases gradually rather than coming all in a flood. It is probable that it will turn out just this way.

Profits Adversely Affected

Unquestionably the straight-time plan, because of this abnormal development in the hog departments, has adversely affected profits. The firm is overpaying its largest labor unit under this make-up arrangement. But it is expected that this will average out in years of larger hog supplies, so that in the last year or two before 1939 costs should be proportionately lower. The company in 1935 slipped from its usual top place in percentage of profits to sales for the industry, down to sixth position—largely because of the overpayment in the hog gangs.

It has, in return, stabilized its labor situation materially and greatly decreased the relief load in its home town. Labor turnover has decreased, partly because of a seniority layoff rule but also because of the regularity of employment and income under straight time. This has meant a material saving through eliminating much of the cost of breaking in new people.

No Marked Speed-Up

Incidentally, there has been no noticeable speeding-up of production in any departments that have been on straight time for more than a year. At the outset, when the people realize that they are free to go home just as soon as they finish the day's work, whether this comes at 2 o'clock or 6 o'clock, they raise the pace and invariably find ways to shorten the day's work. All of this increase, however, comes in the first few

INSURING YOU AGAINST NEGLECT
The correct oil film to each individual bearing... automatically
Crompton & Knowles loom
BIJUR
AUTOMATICALLY Correct LUBRICATION
● Expensive "I-forgot's"... the faults of any imperfectly controlled method of lubrication... may heavily burden maintenance and production costs. A BIJUR lubricating system unfailingly protects your machine against such neglect... Insures, too, the soundness of your investment. Each bearing... whatever its size, speed and load...is automatically fed the amount of oil it individually requires!
BIJUR LUBRICATING CORPORATION LONG ISLAND CITY, NEW YORK
705

weeks. Thereafter, having found their new pace, they hold it rather evenly.

It is noticeable that when a conveyor-paced department goes from hourly wages to straight time, the people soon demand that the conveyor be speeded up—despite the fact that until then they have perhaps been complaining that the speed was inhuman! They go to hard work immediately they go on straight time, of their own choice. There is, of course, some slight advantage to the company through the decrease of power, light, water, and other services that are a factor of time rather than of production.

An interesting effect has been noticeable in the local credit situation. Austin merchants report that they find the straight-time people are good pay, while they have their customary difficulties with the folk on hourly wages. One merchant reports:

"A man who has been owing me money for a long while comes in some day and says, 'Well, I've finally got on straight time. Now I know what I'll have to spend every week, and I can do some planning. Look here, you just put this old bill off to one side. We'll pay cash for all our stuff from now on. And I'll pay you $2 a week until we get the old one cleared up. How's that?' You know how that is with me — it's perfect. And these straight-time workmen keep their agreements, because at last, after a lifetime of not knowing where they will be from one week to the next, they now know exactly what they can do.

"You know, from a long experience as a merchant in an industrial town, I can tell you what the biggest credit hazard is. It isn't the intentional dead-beat. It isn't the fellow who has hard luck and gets behind. It's the man who gets long hours for two or three weeks, gets to feeling nigger-rich, and comes in and buys more than he can possibly pay for on his average yearly earnings. Thank heaven, the straight-time plan has practically done away with the nigger-rich in this town. And the sooner they get the whole plant on that method of payment, the better it will suit me and every other legitimate merchant in Austin."

Your Inventory a Graveyard?

(Continued from page 45)

cern we did some work for made literally thousands of products. Over a long period no real check had been made on the quantities carried. With only a superficial investigation we found large stocks, many of them virtually obsolete, sufficient to meet the demands of nearly a hundred years.

A publisher with a world-wide business furnishes the third example of the dangers in not watching the inventory. This concern, after a prosperous business for many decades, was faced with the necessity of closing its plant. Early in our study of the business we found that the inventory was markedly out of proportion to what it should be. It had been accumulating for nearly fifteen years and no one seemed to know exactly what it consisted of.

The stock was first carefully analyzed and incoming orders were filled out of the accumulated inventories. We then recommended intensive, well-directed sales efforts to dispose of the surplus. It was found, for instance, that in some cases shipments to certain foreign countries that had been good customers had virtually ceased. Next the past records of the company were investi-

You can be glad when there's no work for the maintenance man . . . when production's running smoothly. The less fixin' up he has to do, the better off you are. Breakdowns mean costly delays—time losses for men and machines—extra expense.

P&H cranes will ask mighty little of your maintenance department. They're designed with the liberal safety factors to meet the toughest requirements; to deliver service without interruption for years to come. This well-known reliability is the result of long experience with all sorts of material handling problems . . . of 50 years' leadership as America's largest builders of overhead handling equipment. This is the practical experience that saves you money whatever your particular handling problem may be. Write for Bulletin 131.

Electric welding of end trucks, gears, etc., gives P&H cranes still greater strength and reliability.

HARNISCHFEGER CORPORATION
4525 West National Avenue *Since 1884* Milwaukee, Wisconsin

P&H ELECTRIC HOISTS ELECTRIC CRANES

gated and future business was forecast. As these efforts exhausted the surplus, production was again resumed with one eye always fixed on the forecast.

A new line of related products was then recommended with the result that labor lost relatively little time during the transition period. Because of these and other changes the company was able to vacate and rent one-third of the space it had occupied.

Less Than One Turn a Year

One of the problems that confronted us recently was that of the manufacturer of a sheet metal product who also made tools for its application. We found on investigation that he was turning his inventory less than once a year. Obsolescence on the tools, as a result, ran relatively high, approximately 5 per cent a year, while that on a sheet metal product averaged 2 per cent. By the time we had charged necessary storage and rental for the space the finished articles occupied, as well as insurance, taxes, and other carrying charges, the cost of that inventory had run up surprisingly.

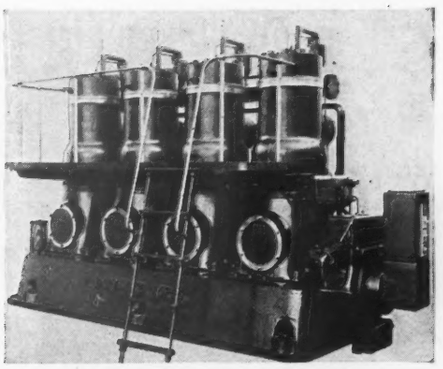
As a way out we suggested that the entire inventory be divided into four groups. The first consisted of currently salable articles that could be used in filling orders; the second, articles moving at the rate of 20 per cent a year; the third, obsolete inventory in which there had been no movement for three years; the fourth, scrap with no potential sales. Everything was carried on the books at full value.

We recommended that old material be reconditioned where possible and sold, and that all salable surpluses be turned into cash. We also devised a method of production planning to prevent excessive inventories, and set up adequate reserves for inventory write-ups.

As a result, much of the inventory that had been accumulating for 20 years was sold—some of it, of course, at a big sacrifice.

Another concern manufactured a highly seasonal consumption article of which there were literally thousands of types. Sales requirements during the season were much greater than the plant was able to produce. It was the company's practice to borrow approximately $500,000 each spring to secure capital to build up its inventory.

Through a system of planning and production control, plus a forecast of shipments based on past experiences and other factors, it was found that requirements could be built up grad-



4-Cylinder Model 32E14 Diesel Engine

MORE PROOF

DeVILBISS EQUIPMENT Spray-Finishes for Fairbanks, Morse & Co.

For proof of the efficiency of DeVilbiss Equipment, consider the experiences of leaders in all fields of manufacture who rely on this equipment to do a fast, dependable finishing job.

These manufacturers have standardized on DeVilbiss after extensive testing, and in all instances, they have found that it measures up to every requirement of constant daily service. They know that DeVilbiss Equipment produces better, more lasting finishes—saves time and labor — reduces production costs. Investigate the latest developments in DeVilbiss Spray-Finishing and Exhaust Equipment, and how they can be applied in your finishing department.

THE DEVILBISS COMPANY · TOLEDO · OHIO

New York *Philadelphia* *Cleveland*
Detroit *Chicago* *St. Louis*
San Francisco *Windsor, Ontario*

Direct sales and service representatives available everywhere

DeVilbiss

CLEAN AIR

a Tonic that Boosts Workmen's Production

Coppus Air Filters can remove even the *finest* dust particles from the air in your plant—microscopic dust, commonest, most troublesome, hardest to eliminate—far harder than large-size dust.

Dust counts and light reflection tests show Coppus Air Filters pass cleaner air than any other commercial filter—up to 95.6% of all dust 2 microns (0.00008″) in size and smaller dust. Each installation is built to the efficiency the individual plant requires.

Other profit opportunities open to you, through filtering the air with a Coppus Air Filter:

CLEANER EQUIPMENT & MACHINERY — less labor cleaning them, since the filtered air *keeps* them clean.

PROTECTED PRODUCT PURITY — taste, color, etc. kept strictly to standards, impurities eliminated, your reputation guarded and sales made easier.

RECOVERY OF VALUABLE MATERIAL — now going to waste in the air, where dry products are processed.

TWO TYPES OF COPPUS AIR FILTERS

Unit Type, and the Dry-Matic, the only self-cleaning dry-type filter.

Write for Bulletin F-350-1 (Dry-Matic) and F-320-3 (Unit Type).

3330

COPPUS AIR FILTERS PASS Clean AIR

ENGINEERING CORPORATION

375 PARK AVENUE, WORCESTER, MASS.

Sales Offices and Distributors Listed in THOMAS' REGISTER

In SWEET'S — Steam Turbines, Air Filters Blowers and Heat Killers

ually without any borrowing. The concern saved substantially through its ability to finance its own inventory; equally important, it stabilized its production so that its labor was employed at a much steadier rate than before.

It is evident from the examples that uncontrolled inventories may not only mean the difference between profit and loss, but may also bring about the dissolution of an otherwise prosperous business.

To Some a Catch-All

Such inventories accumulate for a variety of reasons. One reason is that many manufacturers do not define "inventory". To them it is a catch-all like the miscellaneous column in a table of figures. Everything that has no definite place elsewhere automatically gravitates to inventory.

Another reason is that some people have an inherent dislike for throwing anything away. As a consesuence the inventory may be cluttered up with products that have long outlived their usefulness. Things that should be junked are carefully saved and figured into the inventory year after year at totally fictitious values.

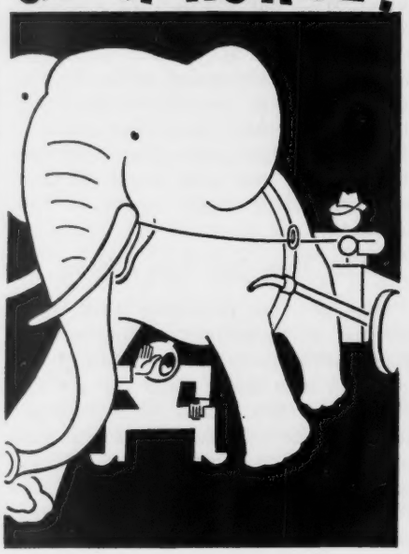
But the most prevalent reason for unbalanced and extravagant inventories is that too many manufacturers are without an adequate system of production control, coupled with an accurate business forecast. If a concern will take the trouble to study past records and forecast future business possibilities, and then keep a tight rein over production, there will be little danger of an inventory piling up beyond the reasonable and practical point.

With requirements and production facilities both known factors, it becomes merely a matter of simple arithmetic to keep the inventory in a healthy condition.

Ray of Sunshine

It would be good business if every executive would first carefully define what he means by "inventory," then list and appraise the stock he has on hand with this appraisal kept well in mind. The result would be that many a concern that now finds itself in difficulties would begin to see at least one little ray of hope and sunshine. Unbalanced inventories are not the only, nor by any means the chief, cause for business failure and embarrassment, but they are an important contributing factor — one that can be corrected and controlled by the executive who really wants to take the time and trouble.

GET A HORSE!



Elephant Power is expensive when you have a small job to do . . . Coppus Steam Turbines save you money on small-H.P. jobs.

They are almost the only steam turbines built in small sizes—fractional to 150 H.P., with prices in proportion. When the job is a small one, you don't have to invest in a large turbine—remember Coppus.

Depreciation and maintenance costs are less, too . . . because the original investment is smaller.

Why Steam Turbines?

1. Smaller power bill
2. No sparks—safe
3. Wide speed range

And Coppus Steam Turbines come with individual nozzle control and built-in speed reducers. No accessories to buy.

Write for Bulletin 135–8

3329

COPPUS AIR FILTERS PASS Clean AIR

ENGINEERING CORPORATION

375 PARK AVENUE, WORCESTER, MASS.

Sales Offices and Distributors Listed in THOMAS' REGISTER

In SWEET'S — Steam Turbines, Air Filters Blowers and Heat Killers

NO CONTAMINATION WHEN PACKAGING MACHINES GET *Alemite Controlled Lubrication*

● Alemite Controlled Lubrication puts lubricant into the *bearings*—not into the product. There is no dripping—no oozing—no contamination of products destined for human consumption. That's why so many packaging, sealing, wrapping, labeling, and processing machines are equipped with Alemite Lubrication Systems.

Bloch Bros. Co., manufacturers of Mail Pouch Chewing tobacco, are so jealous of their product's quality that every package is subjected to fluorscope inspection. They exert all possible precaution to keep Mail Pouch *clean*, and Alemite Controlled Lubrication plays an important part in this cleanliness.

Cleanliness, however, is only one of the advantages which have turned thousands of manufacturers to this modern method.

Alemite Controlled Lubrication *prevents* bearing failures by forcing lubricant to every part of the bearing surface. Machines run smoother, last longer, maintain production schedules better. Power costs are cut as starting torque is reduced. And because Alemite Guns meter the lubricant, waste is eliminated and lubricant costs go down.

There is an Alemite System to fit *your* requirements. Installation is easy—quick—inexpensive. Production need not be interrupted. Get the important facts from our FREE manual, "The Case of Alemite vs. Friction." Mail the coupon today.

ALEMITE—*A Division of Stewart-Warner Corporation*
1870 Diversey Parkway Chicago, Illinois
Stewart-Warner-Alemite Corp'n. of Canada, Ltd., Belleville, Ontario

ALEMITE
REG. U. S. PAT. OFF.
WORLD'S LARGEST MANUFACTURERS OF LUBRICATING PRODUCTS

Enjoy Horace Heidt and his Alemite Brigadiers every Monday Evening, CBS Coast-to-Coast Network. See local papers for time of broadcast.

ALEMITE—*A Division of Stewart-Warner Corp'n.* Dept. L
1870 Diversey Parkway, Chicago, Ill.
Please send your lubrication manual, "The Case of Alemite vs. Friction."

*Name*_____

*Address*_____ *State*_____

*City*_____

*Firm Name*_____

Photo courtesy Thompson Products Co.

USE ROLLER CHAIN

Baldwin-Duckworth solves another problem—this time it's heat. The conveyor illustrated, equipped with stainless steel roller chain, carries automotive parts through a normalizing furnace. Time in furnace — 3 minutes at 1600°F. — 20 minutes out at room temperature—and repeat—24 hours a day—day after day. We're proud of this performance. It proves once more how Baldwin-Duckworth engineers solve problems of power transmission, elevating, and conveying. But whether the situation requires standard or special chain—with or without standard or special attachments, and regardless of the chain chosen or its cost, every part must conform to the highest standards of workmanship established by Baldwin-Duckwoth. Baldwin-Duckworth Chain Corporation, Springfield, Mass.

BALDWIN—DUCKWORTH

TOUGH ENOUGH FOR THIS

No towel can earn its keep that isn't tough enough to stand up under the mauling of hard-working hands. Yet this quality must be achieved at no sacrifice either in proper size or absorbency. Because Onliwon Towels combine these three essentials in such perfect balance, they have a unique record for downright economy in actual use. Phone your local A.P.W. representative today and let him show you with facts and figures how Onliwon Towels can bring to your washrooms added protection to health with increased economy as well. Or, write for samples to: A.P.W. Paper Company, Albany, N. Y.

A.P.W.

Onliwon Towels

CHICAGO RAWHIDE

Gears and Pinions

Take all the wear

IN every plant, in many machines, there are points where "Chicago Rawhide" Pinions will end destructive vibration and chatter, and silence nerve-racking noise. Make it a rule to check "Chicago Rawhide" for every gear application. Cut gears or blanks are available in any size or shape.

Write for new Gear Catalog and Manual

Chicago Rawhide Mfg. Co.
1295 Elston Avenue
Chicago Illinois

Branches:
New York Pittsburgh
Boston Cleveland
Philadelphia Detroit
Cincinnati St. Louis

C MECHANICAL LEATHERS R

Revamped Shipping Room for Group Bonus

(Continued from page 47)

therefore stored in an adjoining room, and orders are picked out, loaded on a pallet, and dispatched via gravity roller conveyor to the shipping area where, if the order calls for both toothbrushes and hairbrushes, the two sections of the order are correlated and packed together in the same shipping case.

The packing is done on another section of roller conveyor that runs across the packing area and then makes a wide loop that takes the cases across the scales and past the stenciling cabinet, after which they accumulate on the conveyor against the several express and freight pickups that are made during the day. A 16-ft. portable roller conveyor bridges the gap between this storage section and the shipping platform.

That, as well as I can tell it, is what we did to the shipping room before we put the men on bonus. I have indicated the advantages of the new layout as I went along. There is, therefore, no need to rehearse them here. The job as we do it now may not be perfect. In fact, we can see some flaws in it, but they are minor ones and have never been serious enough to disturb the orderly workings of the group bonus plan that we were now ready to set up.

(In a second article, scheduled for January publication, Mr. Leach will continue with a description of the bonus plan that was installed—Ed.)

Work at Work Level

(Continued from page 49)

gear that engages it. Therefore the rail was removed at this point, and the wiring is done by men who ride the body so that they will not be slowed down by the body's swings. A little farther along, back comes the monorail.

Toward the end of the line, after the monorail has been missing for a long stretch while jobs are performed by men riding inside and outside, we come to the striping operation, a very delicate paint job. Once more the monorail is used. Obviously, a thin stripe could not be applied to a moving body if there were any side sway whatever.

When the last operation has been performed, a dolly is waiting where it has been pushed up against some

Competition sets your PRICE LIST Selling Price

Live Rolls, in center, move material between operations. Material transferred to side lines, Idler Rolls, while machine operations performed, then back to main line. Below: Tote pans go from stock room to main line.

★ ★ but you set your own PRODUCTION COSTS!

★Decades have passed since a manufacturer could set his own selling price. His price must be *at* or *near* the market—if he expects to get orders.

But what about production costs? Here, there is an opportunity to do something about it. And here, Logan Conveyors play an increasingly important role.

Conveyors foster "straight line" production and so cut out unnecessary backtracking and double handling. Conveyors eliminate the fetch-and-carry criss-crosses which eat into efficiency. Savings in Time, Effort, Floor-Space and Pace-Making are but some of the cost-cutting functions which Logan Conveyors perform in many factories today.

Perhaps there are opportunities in your own plant. The nearest Logan engineer will gladly discuss them with you, or write for bulletin "7 Economies."

LOGAN CO., Inc., Louisville, Ky.
510 Buchanan St.

HELP YOU GET OUT THE WORK

Logan Conveyors

LOUISVILLE

Door Operating Costs Reduced!

KINNEAR
ROLLING DOORS

DOOR SPECIALISTS

That Can Turn The Trick For You

The rapid operation—convenience—saving of space—remarkable durability that Kinnear Doors provide can be afforded any factory building. For Kinnear makes several types of doors . . . all of the upward-acting design. And if they do not have a design to fit your exact requirements Kinnear will build a special door. Whether used on new or old buildings, for service or fire protection purposes—manually or electrically operated—Kinnear Doors save time, labor and money . . . and reduce maintenance cost for years to come to a minimum. Let us consult with you on your door needs. Our Sales Engineers will gladly submit recommendations. No obligations.

Offices and Agents
in All Principal Cities

The KINNEAR MFG. CO.
1540-60 Fields Ave., Columbus, Ohio

Yes! We would like to have your catalog describing Kinnear "Money-saving" Rolling Doors and Grilles. No obligation.

Name _____

Address _____

City _____ State _____

guide stops by the man who does the handling here. The monorail ends, the overhead chain lowers a few inches, the body and buck move onto the dolly. Right here the two end yokes are unhooked from the fixtures on the ends of the buck frame. The body is picked up by an electric hoist using hooks heavily padded to avoid marring the finish, and is lowered through the floor to meet its chassis.

A man pushes the frame on the dolly back to the chain line, the yokes are hooked back onto the frame. Two men rock the device, the dolly comes free, the buck continues along the chain to a point where it will go onto another dolly and be pushed under the opening from the floor above, as described at the outset. Meanwhile, the vacated dolly is pushed back some 50 ft. to the end of the body line, there to receive another body.

The whole layout is a marvel of economy, flexibility, and efficiency. And there is no good reason why the same basic teaming of chain and monorail might not be used in dozens of other industries.

We Have to Use Instruments

(Continued from page 58)

inspector merely moves the pointer of the sending unit to the desired message, which automatically moves the pointer on the receiver to the corresponding point on its dial. More than 40 different messages can be sent over this system, which keeps the roller accurately informed as to the surface gage, widths, and lengths of product leaving the mill.

Because of the exacting demands of users of sheet steel, the product of the tandem mills must be rolled to close limits of thickness. To indicate continuously and accurately to the roller the variation above and below the specified thickness, two electric limit gages, one for the 76-in. and one for the 54-in. tandem mills, have been provided. Each gage consists essentially of three separate units—an electric head for gaging the metal; a power unit to provide a 60-cycle supply at the proper, constant voltage; and a micro-ammeter to indicate any variation from the specified gage. Two of these micro-ammeters are used. One is located on the first stand, and the other on the third stand. The electric head is located just after the third stand.

Some of the electrically operated instruments that have been listed are

CAPTURE THAT DUST

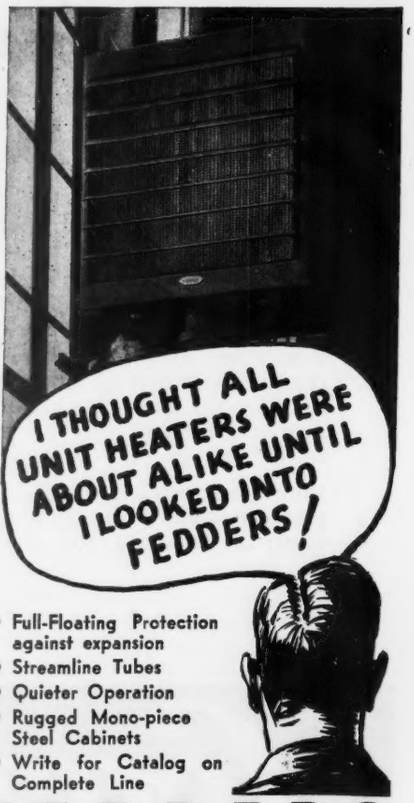
Prevent Hazards of Occupational Diseases

AVOID RISK—SAVE MONEY

Exclusive territory open to responsible distributors and wholesalers.

SUPER SUCTION machines take dust produced in operation from point of origin in grinding, polishing, sanding, etc., from materials in process, machines, products, stock rooms, bins, floors, walls, and industrial equipment. Supers capture dust anywhere, any time. Used in connection with production processes in work hours and to clean up the plant when machines are idle. Readily adaptable to any cleaning task. Move 190 cubic feet of air, at 3 miles, per minute. No heat loss—air is filtered and returned to room pure and warm. Rugged, powerful, long-life outfits, readily portable. Standard tools. Special adaptations to almost any operation. Our free trial offer permits you to make your own demonstration. Write for data. The National Super Service Company, 1945 N. 12th Street, Toledo, Ohio. Suction Cleaner Specialists for 26 Years.

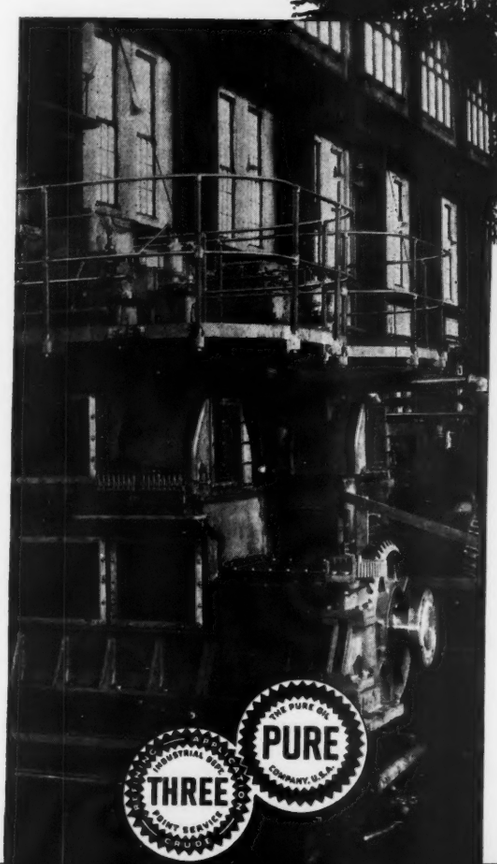
Supers Kill Risks



- Full-Floating Protection against expansion
- Streamline Tubes
- Quieter Operation
- Rugged Mono-piece Steel Cabinets
- Write for Catalog on Complete Line

FEDDERS
MANUFACTURING CO.
BUFFALO, N. Y.

A WORD TO THE WISE . . .



● That the Diesel type of engine is a most economical source of power is granted, provided it is being operated as its manufacturer intended.

To make sure you are getting the maximum results from this source of power, why not have Pure Oil's Industrial Department give your power plant a complete scientific check up.

A phone call will bring an experienced lubrication engineer who will be glad to render this service and to explain to you the advantages of Purodiesel oils.

Comprising Pure Oil's Three Point Service is: 1. Selected Crude. 2. Skillful Refining and 3. Scientific Application

THE PURE OIL CO.

U. S. A.

PRODUCERS, REFINERS, MARKETERS OF A COMPLETE LINE OF PETROLEUM PRODUCTS

"NEVER SLIPS WITH CLING-SURFACE"
Says Plant Superintendent
23" 2-ply leather belt, from 21", 115 HP motor pulley (60 RPM) to 12' driven pulley on 75-ton compressor, manufacturing about 75 tons of ice daily. Pulley centers 19½ feet.
RUNS 26" SLACK

Run Slack for 22 Years
—without a stop for repairs!

"We never have trouble with slipping as long as we use Cling-Surface," says the Superintendent of this Chicago ice-manufacturing plant. "Some years ago, for a short time we had difficulty obtaining Cling-Surface and tried everything we could put our hands on, without success. With or without tension, the belt slipped. Then, we started using Cling-Surface again and our troubles were over. From that day on, though always run slack, this compressor belt has never slipped—and Cling-Surface has preserved it so well that it has never been down for repairs. Today, though 22 years old, it is still in good condition."

In countless other plants throughout the world, Cling-Surface has proved its unusual qualities which result in operating savings reaching large amounts annually. It does not simply *reduce* slipping, but actually *stops* it so completely that tension on the belt is unnecessary. Thus, use of Cling-Surface not only saves power but means longer wear for belt, bearings and shafting—lowered lubrication costs and fewer breakdowns, because of slack operation.

Further, Cling-Surface *preserves* belting. In contrast to ordinary "surface dressings," Liquid Cling-Surface penetrates into every fibre of porous belting—energizes, waterproofs, maintains pliability—adds years to belt life. Effective on all types of belting and ropes.

A test of Cling-Surface will show you, too, savings comparable to those realized in this and 50,000 other plants throughout the world. Why not test it for the next 60 days? Your mill supply distributor can supply you.

TRY CLING-SURFACE 60 DAYS AT OUR RISK!

On request, our distributor will furnish a 60-day trial supply. If, after 60 days, your belts have not gained in liveliness and elasticity and are not delivering more power than ever before, you pay nothing! Ask your mill supply distributor or write the Cling-Surface Company, 1058 Niagara Street, Buffalo, New York.

CLING-SURFACE

Preserves power belts • Prevents slipping • Permits slack operation

indispensable to the accurate control that is essential in an industry as closely articulated as continuous strip-sheet production. Other instruments, such as gage controls, are not absolutely indispensable but they aid in producing a better product.

X-Rays Tell Inside Story

(Continued from page 62)

voltage are also inspected to insure absence of foreign materials.

Insulated cable in small sizes is inspected to safeguard the quality. Bent or broken conductors, thin insulation, and defective splices are easily detected by X-ray examination. Several cables are inspected at the same time while moving continuously before the viewing screen.

Fluoroscopic examination of mail and packages has been applied in some instances by customs officers to detect smuggling, and by post office officials to locate hazardous objects being sent through the mail.

During the past year food products manufacturers have become interested in the possibilities of X-ray examination as a safeguard against the inclusion of foreign materials. Many lawsuits are filed every year to recover damages alleged to be caused by foreign materials in edible goods. In spite of extreme care, there is sufficient danger of foreign material in such products to justify X-ray examination. They may be inspected before or after packaging, depending on their nature, manufacturing methods, and the types of foreign material that might be included.

On a conveyor belt, packages may be inspected at the rate of 20 to 50 per minute, resulting in a low cost per package.

Candy manufacturers have led in the adoption of this new method of inspection. Use of electromagnets, sieves, air, and photocells is rather extensive in this industry for the detection and removal of foreign bodies from the raw products. Each of these methods has some limitations, and none gives an indication of the contents of a package. X-ray inspection of the finished product is the only method by which defects can be seen inside the package.

One manufacturer recently learned that there was a foreign substance in some one of 1,000 finished and sealed packages. Without having to open or otherwise damage any packages, about one-fourth of them were

DISTINGUISHED SERVICE

SERIES "77" Bassick TRUCK CASTERS

The finest testimonial of outstanding quality and distinguished service is the steadily increasing sale of these remarkable truck casters—best sellers over all other types.

The chief reason for the leadership of Series "77" is an entirely different principle of ball race construction which provides an amazing new ease of swiveling action. The heat-treated malleable alloy material, with tensile strength of 80,000 pounds per square inch, gives a sturdiness that endures the shocks of fast and rough handling.

• • •

Discover for yourself the advantages of this caster, which is one of the 13 distinct types of Bassick Truck Casters. There is a size and type in the Bassick Line for every requirement.

THE BASSICK COMPANY • BRIDGEPORT, CONNECTICUT

Canadian Factory: STEWART-WARNER-ALEMITE CORPORATION OF CANADA, LTD., BELLEVILLE, ONTARIO

GOT A PENCIL*?

Here's a Crossword† Puzzle any SAFETY ENGINEER Can Solve

Across 1. An effective carbon-dioxide fire extinguisher. (Used for protection of thousands of industrial plants.)

2. Snuffs out, extinguishes. (LUX carbon-dioxide does this faster than any other type of extinguishing agent.)

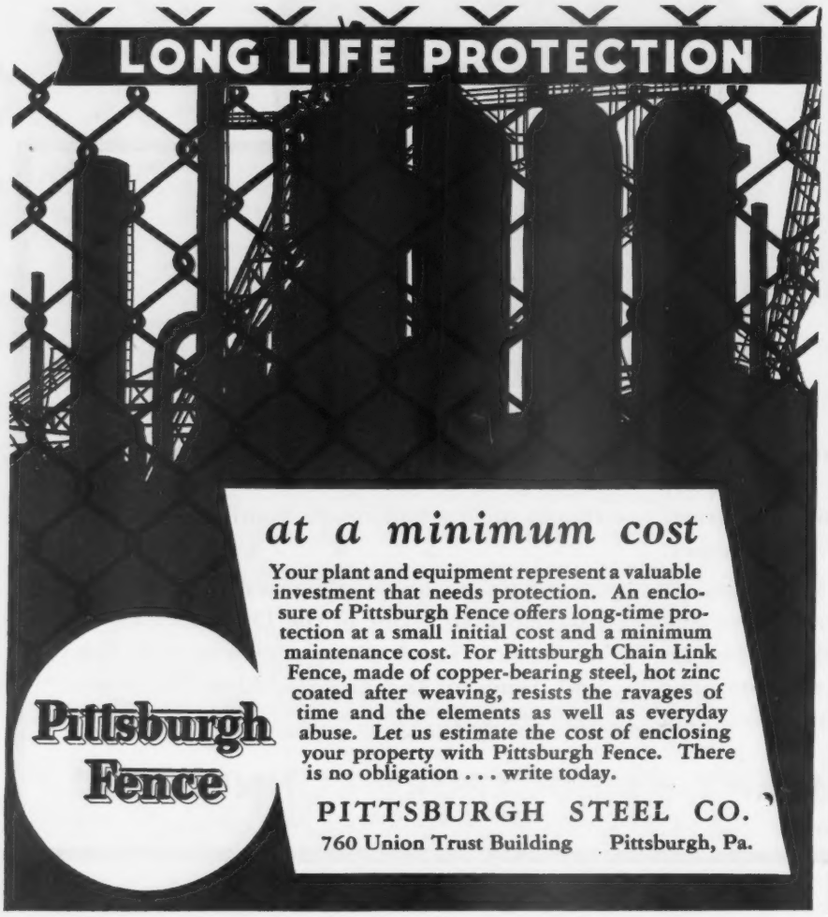
3. Blazes, conflagrations (which destroy over $250,000,000 in industrial property each year).

* *Send for answer book* containing solution to your most hazardous fire protection problems.

† This isn't really a crossword puzzle. But then nobody has a cross word for LUX.

Walter Kidde & Company

122 West Street Bloomfield, N. J.



at a minimum cost

Your plant and equipment represent a valuable investment that needs protection. An enclosure of Pittsburgh Fence offers long-time protection at a small initial cost and a minimum maintenance cost. For Pittsburgh Chain Link Fence, made of copper-bearing steel, hot zinc coated after weaving, resists the ravages of time and the elements as well as everyday abuse. Let us estimate the cost of enclosing your property with Pittsburgh Fence. There is no obligation . . . write today.

Pittsburgh Fence

PITTSBURGH STEEL CO.

760 Union Trust Building Pittsburgh, Pa.

passed quickly under the fluoroscopic viewing screen before the offending package was discovered.

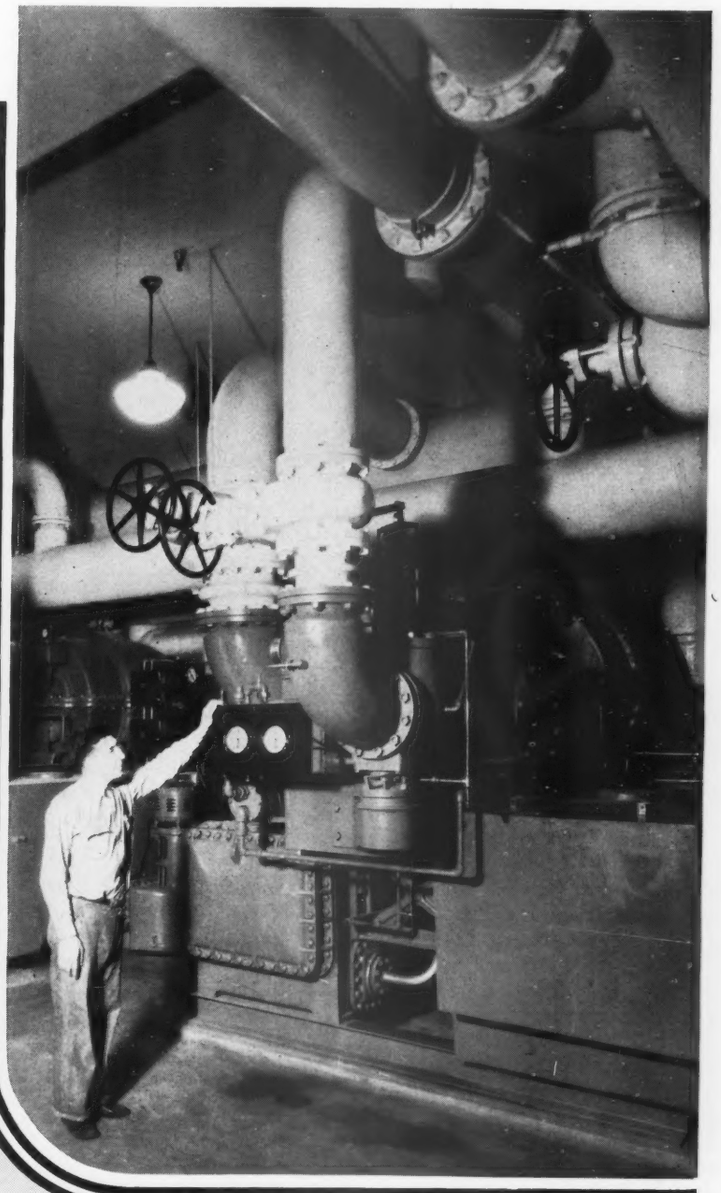
Another rapidly developing use for X-ray in industry is the study of crystal structure. It constitutes a new method of chemical analysis, study of the constitution of alloys, and other fine structure analysis. Although essentially a research tool, X-ray crystal analysis is being applied to production and the control of quality.

By its use, small quantities of chemicals and chemical compounds may easily be analyzed. Mixtures such as ores, dusts, and residues may be analyzed both qualitatively and quantitatively. The crystallinity or non-crystallinity of a material may readily be determined—a matter of great importance in the manufacture of synthetic resins, glass, carbon blacks, clays, and catalysts. Whether a material is crystalline or amorphous, the lattice structure, atomic and molecular arrangements, inherent particle size, particularly in the sub-microscopic region, the state of aggregation, the effects of aging and thermal treatments—all of these can be determined.

The X-ray furnishes a certain method for differentiating between suspensions and true solutions, and gives a permanent record. Effects of working metals by rolling, drawing, forging, or spinning, and the structural changes involved such as fragmentation, internal strain, distortion, preferred orientation, and even elastic stresses, can be studied and correlated with desired physical properties of the final product. The efficiency of annealing to relieve stresses, the effectiveness of thermal treatments, grain growth, recrystallization and age-hardening phenomena, and fatigue effects are other factors in the fabrication of metals about which the X-ray method of analysis gives exact information.

Study of the structures of organic compounds, both natural and synthetic, has been greatly facilitated by X-ray crystal analysis. X-ray diffraction studies have led to a broader knowledge of the structure and properties of such materials as proteins, keratin, natural cellulose and plant fibers, starches, chitin, and rubber. They have given a complete understanding of the mechanism of lubrication and a method for quantitatively comparing lubricating values of oils and greases, and have been directly responsible for improved methods of producing rayons, surgical sutures, and plastics. Their use has provided a logical classification of synthetic resins, and the most satisfactory method of grading cotton, rayon, and textile fibers.

Factory Management and Maintenance *Plant Operation Library*



★

WEATHER MADE TO ORDER
Page 166

HEAT FOR THE PLANT
Page 168

KEEPING AIR FRESH
Page 170

HOW AIR IS COOLED
Page 171

TO REGULATE HUMIDITY
Page 174

LAUNDERING AIR
Page 177

WATCHDOGS OF THE WEATHER
Page 178

WHERES AND WHYS
Page 180

Air Conditioning

JANUARY, 1936

WEATHER MADE TO ORDER

PURE dry air is a mixture of a number of gases, of which oxygen and nitrogen comprise 99 per cent by volume. The remaining 1 per cent consists of carbon dioxide, hydrogen, neon, ozone, and two or three others. However, air in its natural state always contains a varying, oftentimes considerable, amount of water vapor. Dust, soot, bacteria, and other impurities are usually also present, not infrequently in objectionable amounts.

Health, Comfort, Efficiency

From the standpoint of health, comfort, and efficiency, air is seldom at the proper temperature; seldom does it contain a desirable amount of water vapor. Over most of the area of this country the air is too cold and too dry in winter, whereas in summer it is too hot and too moist or, in a popular phrase, the humidity is too high.

During the winter it is not a difficult matter to raise the temperature of the air in offices and workplaces to a satisfactory level, but that alone does not solve the problem. It is common experience that the air of inclosed areas quickly tends to become stuffy and oppressive.

A part of the oxygen breathed in is chemically combined with carbon and exhaled in the form of carbon dioxide. This gas is not poisonous, but it displaces or dilutes the oxygen in the air, causing an increase in the rate of breathing and much discomfort under extreme conditions. Low moisture content or humidity, usually prevailing in winter, tends to result in dry, hard skin, with rapid drying of the mucous membranes of the nose and throat, which predisposes them to infection.

Again, unless adequate provision is made for frequent replacement of the air of occupied areas, body and other odors soon become noticeable. Such odors are by no means a menace to health, but their psychological effect may be highly important in producing a feeling of oppression or discomfort, with resultant lowering of efficiency.

Fumes or gases produced by industrial processes may or may not be detrimental to health, but even when harmless so far as toxic effect is concerned their presence in any considerable amount is unpleasant and likely to result in discomfort.

Bacteria, too, are always present in the air of occupied areas, and although not all varieties are harmful, there is no way of separating the good from the bad; hence, they are all to be viewed with suspicion.

Many industrial processes and materials are even more susceptible to atmospheric conditions than are human beings. A great many materials or substances are hygroscopic, or absorb moisture from the air, which may injure or destroy them. This fact is of great importance to chemical and pharmaceutical manufacturers, to mention only two of many industries that have to reckon with the weather. On the other hand, the presence of a fairly large amount of moisture in the air is essential to the smooth operation of some processes, or the production of the desired quality of output. Importance of the moisture content of the air in textile plants, tobacco factories, and printing establishments is well known.

Again, dust is highly objectionable in fine wood and metal finishing, and many other operations. Gases or fumes may play havoc with other processes. Close control of room temperature is important in many industries, ranging from brewing and food products to metalworking. So there is a long list of industries or manufacturing processes that are affected in greater or less degree by the temperature of the air and the amount of moisture and impurities in it.

What "Air Conditioning" Is

The function of air conditioning is to produce air of the desired temperature, humidity, and purity. Complete air conditioning involves simultaneous control of temperature, humidity, air motion and distribution, bacteria, dust, poisonous gases, and odors. Control of certain of these factors is of much more importance in some instances than in others.

The term "air conditioning" has frequently been applied so loosely and erroneously as to mean almost anything or nothing. Furthermore, in the popular mind air conditioning has come to be associated more definitely with air cooling. In order to clarify matters the industry and the Better Business Bureau have recently adopted these three definitions:

1. Summer air conditioning should, as a minimum, cool, dehumidify, and circulate the air.
2. Winter air conditioning should, as a minimum, heat, humidify, and circulate the air.
3. Year-round air conditioning should, as a minimum, cool and dehumidify the air in summer, heat and humidify it in winter, and circulate it.

Details of how to control temperature, humidity, and other factors will be given in the succeeding chapters. It is important, however, to understand principles of air conditioning.

Water vapor is always present in atmospheric air, although the amount varies widely with the temperature of the air and the location. Over desert regions the amount of water vapor in the air is very small, whereas over and around large bodies of water it is likely to be high. In any event, however, water vapor is to be considered as steam at a very low pressure, with properties similar to those of steam.

Regarding Humidity

Another fact of prime importance is that for any temperature there is a corresponding partial pressure of the water vapor at which it is in the saturated state. Then its condition is similar to that of saturated steam. In the saturated condition of the water vapor the air is also regarded as saturated, because it contains the greatest amount of vapor that can be held at that temperature.

As the temperature of the air increases it becomes capable of holding an increasingly greater weight of water per unit of volume. If the air is at higher temperature than that which corresponds to the partial pressure of the water vapor, the latter is superheated. When the temperature falls below the saturation point, commonly termed the dew point, enough of the vapor condenses out to lower the pressure to the point where it corresponds to the new temperature. A familiar example of this process is the sweating of cold water pipes on a hot day when the humidity is high.

Moisture in the air is commonly referred to as humidity, which may be expressed as absolute or relative. Absolute humidity expresses the

water vapor content in grains per cubic foot of air. Relative humidity, on the other hand, expresses the ratio between the amount of vapor in the air at a given time to the amount of vapor in saturated air at the same temperature. The term humidity, as it is popularly used, actually refers to the relative, rather than the absolute, humidity.

When air is heated its relative humidity decreases, because the actual quantity of moisture in a given volume remains the same, whereas the quantity that could be held increases.

One of the most widely used methods of measuring the relative humidity involves the use of the wet- and dry-bulb thermometers, usually combined in what is known as a sling psychrometer.

Air Motion

Extensive experiments have shown that comfort depends on maintenance of the proper temperature, humidity, and air motion. Although we have been accustomed to use the dry-bulb temperature as an index of comfort, the humidity and amount of air motion are nearly as important.

In still air we may feel comfortable under several different conditions of relative humidity and temperature. As a general rule, and within limits, we will feel just as warm under a lower temperature, with higher humidity, as under a higher temperature with lower humidity.

The same general situation prevails in moving air, but the effective temperature for a given temperature and humidity is lower than in still air.

It is generally regarded that a relative humidity of 40 per cent is about the minimum desirable limit from the standpoint of health, although condensation of moisture on windows and walls may make it impracticable to maintain this degree of humidity at all times.

Very high humidities are probably not harmful to health, but may cause discomfort from perspiration. Hence, 70 per cent relative humidity is about as high as it is desirable to go.

It was mentioned previously that motion of the air is one of the most important factors in producing a feeling of comfort. When the air is motionless there is a layer of moist air surrounding the body that produces a decided feeling of discomfort, which can be dispelled by a slight breeze.

It is not good practice, however, to allow air velocity to exceed about 50 ft. per min., or to direct air currents of noticeable velocity downward upon the occupants of an area.

Laundered Air

Desirability or necessity of treating air to remove dust, bacteria, fumes, and other impurities depends upon the conditions. In many instances, when the outside air is pure, enough can be continuously drawn in to keep the inside atmosphere sufficiently free from pollution, without causing an undesirably high rate of air motion. Some fresh air must be drawn in, in any event.

What air conditioning can do to increase comfort, needs no comment. Of far greater consequence, economically, are the possibilities it offers for increasing health and efficiency, and making it possible for industry to provide atmospheric conditions necessary for the efficient conduct of many operations.

The Philadelphia Electric Company found, during the first year after the installation of a complete air conditioning system for the main floor of its head office, that lost time due to disorders of the respiratory tract decreased 33 per cent. During the second year the reduction in lost time was 46 per cent.

Time lost on account of colds and similar disorders in a branch office of this company, in which the air is conditioned, was 56 per cent less than in another branch office in which the air is not conditioned.

At the Philadelphia plant of the American Tobacco Company, air conditioning reduced lost time due to illness from 75 employees absent one-half day in 75 days to only 5 employees absent for that length of time in the same period.

In the year and a half following installation of an air conditioning system in the engineering laboratory and offices of the International Business Machines Corporation, more new products were turned out and more production secured at less expense than ever before. It was felt that the results justified putting in a complete system in the factory machine room.

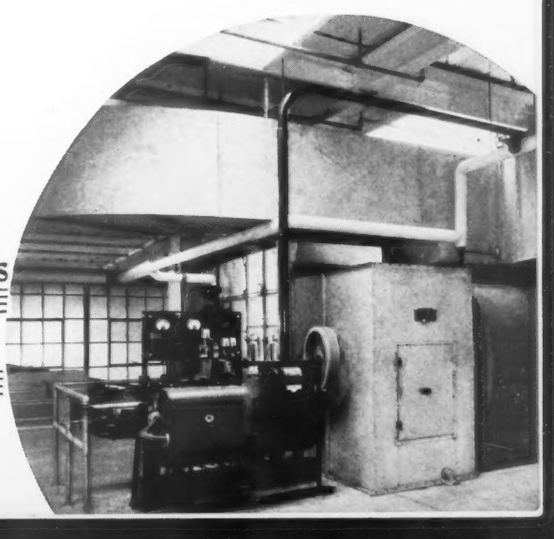
A good example of the important rôle played by air conditioning in industry is found in the plant of the Bristol-Myers Company. One of its products is strongly hygroscopic, which led to serious manufacturing difficulties and almost intolerable plant conditions when the humidity was high.

Conditioning the air of departments where this product is made has eliminated all these troubles and made it possible to turn out a uniform preparation, regardless of outside atmospheric conditions.

Air conditioning made it possible for the manufacturer of a popular brand of cigars to turn out in its New Jersey plant just as good, perhaps better, cigars at a lower cost than could be obtained in its Havana, Cuba, plant. Havana weather is fine for cigar manufacturing; artificial weather is even better.

A manufacturer of cough drops had increasing difficulty in promptly filling orders during the early fall and winter. It was not possible to carry much stock, owing to the tendency of the lozenges to melt and stick together. Installation of air conditioning equipment eliminated this difficulty and made possible a large increase in output without additional manufacturing facilities. An incidental but valuable advantage has been much greater ease of equalizing employment by the ability to smooth out peak production demands.

Altogether, air conditioning is being used in a wide variety of industries, notably such important ones as textiles, food products, meat packing, confectionery, drug and pharmaceutical manufacturing, and printing. This widespread and diversified use of air conditioning equipment is perfectly understandable when it is realized that there are probably several hundred different manufacturing processes in which close control of atmospheric conditions is an essential, even vital, part of the operation.



HEAT FOR THE PLANT

MOST industrial plant heating systems are based on the use of steam or hot water. Gas and electricity as sources of heat possess definite advantages and are sometimes used when the conditions are favorable; usually, however, the price is too high to warrant their use in large-scale heating.

Gravity or Forced Circulation

Hot-water heating systems are of two general types: gravity circulation and forced circulation. With the gravity type, circulation of water is caused by the difference in weight of the water in the flow and return risers. In the other system the water is circulated by a pump.

Piping systems are classified as one-pipe and two-pipe. In the first, the water flows through more than one radiator. With the two-pipe system it flows through only one radiator during a circuit; hence, all radiators are supplied with water of practically the same temperature.

Two-pipe systems in turn are divided into direct- and reversed-return systems. The latter in general give better performance.

An inherent advantage of hot water systems is the ability to deliver heat at any rate desired, up to the maximum capacity.

When exhaust steam is available, it is generally used for building heating, supplemented by live steam if and when necessary. Several different systems of distribution are in common use, the choice among them depending largely on the conditions.

For small plants the single-pipe system, in which condensate from radiators is returned to the same pipes that act as risers for the steam, is popular. Advantages are low first cost and simplicity of installation and maintenance, but improper drainage of radiators caused by leaky or partly closed valves and interference of condensate with the steam flow may result in water hammer.

Vapor systems, also popular for small buildings, have the advantage of using low-pressure steam, only slightly above atmospheric pressure. They are of the two-line type with the return lines separate from the risers. Steam enters the heating unit at the top, and the condensate drips downward. Traps permit condensate and air to be drawn off without admitting steam through the return line. This system provides uniform heating.

Air is removed from the return line, minimizing a problem that necessitates higher pressures in some steam systems. Maintenance of the traps, one of the most important items of equipment in vapor systems, tends to make such systems more expensive to operate than when steam under pressure is used.

For large installations the two-line vacuum return steam system is probably the most popular. This is essentially a vapor system supplemented by a suction pump in the return line. Since steam temperature varies with its pressure, radiator output can be controlled by cutting down the steam supply and operating the vacuum pump to keep the pressure in the radiators below atmospheric. If exhaust steam is used for heating, the pump reduces backpressure on the prime mover, increasing power plant efficiency.

Radiators, Pro and Con

Some form of heat radiator must be employed to transfer the heat in the steam to the air of the area to be warmed. There are several types and arrangements of these devices. The oldest and one of the most widely used methods of heating makes use of cast-iron radiators or pipe coils. This method of heating is the cheapest and simplest of all, but disadvantages include space required by the radiators and difficulty of obtaining proper or uniform distribution of heat.

Of recent years, so-called unit heaters have come into wide use. They consist of a radiator through which steam or hot water is passed, with a fan to draw or force air through it. Unit heaters are available in two general types, the suspended and the floor type. The suspended type is intended to be mounted overhead out of the way.

Floor-type unit heaters are of somewhat different construction, usually consisting of a metal housing which contains the radiator and one or more fans. Cold air is drawn through ducts located in the bottom of the unit, driven over the heating surfaces, and discharged to other ducts which are several feet from the floor, and can be pointed in different directions.

Advantages

Unit heaters have a number of advantages, among which are large capacity in a comparatively small space; they can be located at almost any place desired; piping system required is simple; ease of control; rapid heating; they make it possible to direct the heat and therefore help to secure proper distribution.

In hot weather the fans of unit heaters may be operated to increase comfort by keeping the air in motion, or cold water may be circulated through the radiator and additional cooling effect produced.

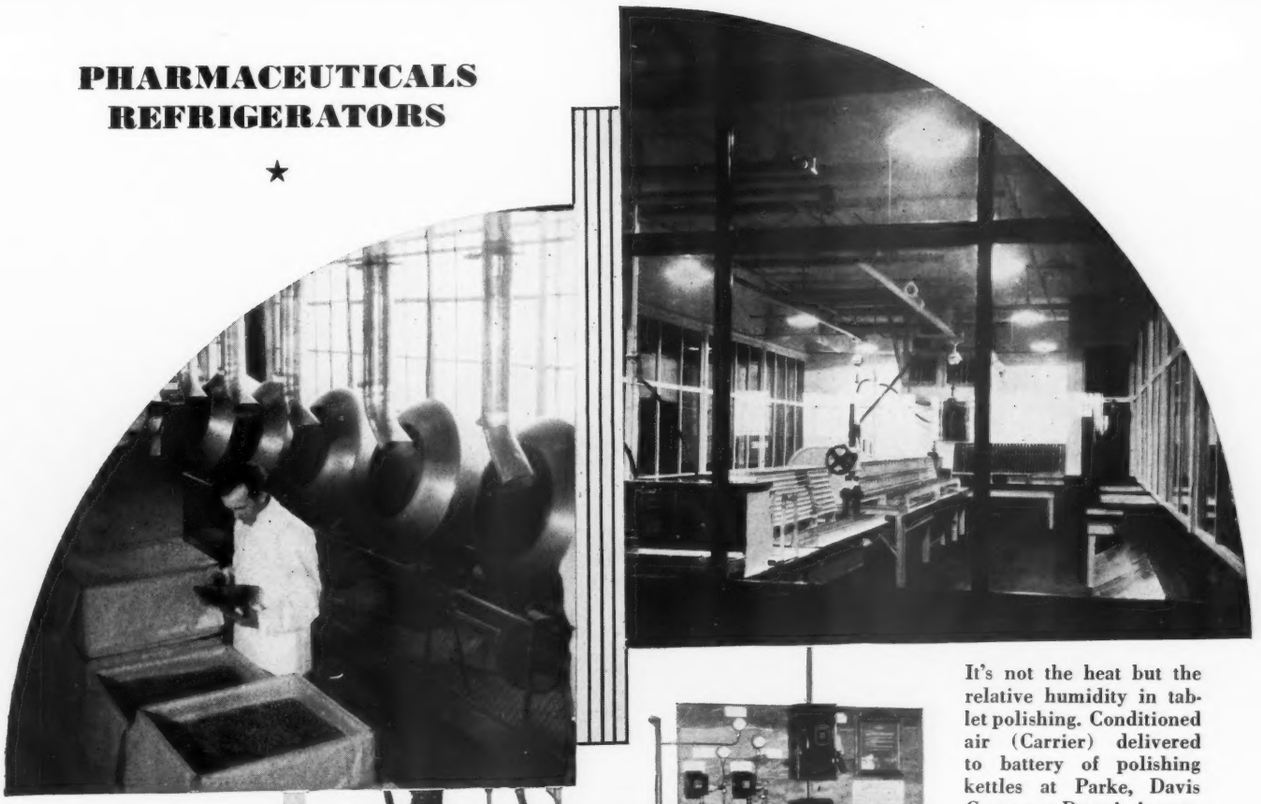
Various makes and designs of compact units are available, which in addition to heating elements also contain the necessary equipment for cooling, humidification, washing or filtering, and circulation of the air. These are known as unit air conditioners, and in many instances offer important advantages.

The so-called fan or central system of heating may be used for heating alone, or it may include equipment for air conditioning. When intended for heating alone, air is drawn into an inclosure or housing containing heating units and is then propelled by a fan through large ducts that lead to and discharge into the area to be heated. Provision is made for returning air from the area to the system, also for introducing the desired amount of fresh air.

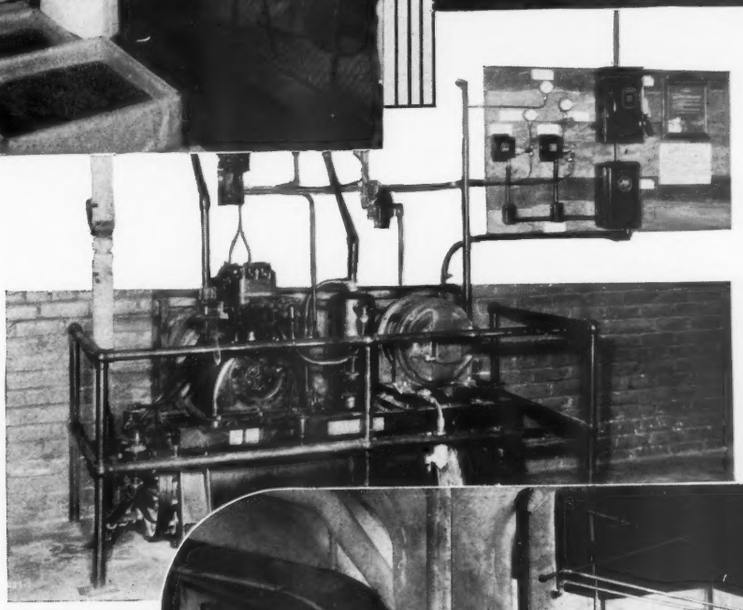
If humidifying, dehumidifying, or washing of the air is required, the necessary equipment may be made a part of the central heating system, or the latter may be made to condition and circulate the air, while heating is accomplished by local radiators or convectors.

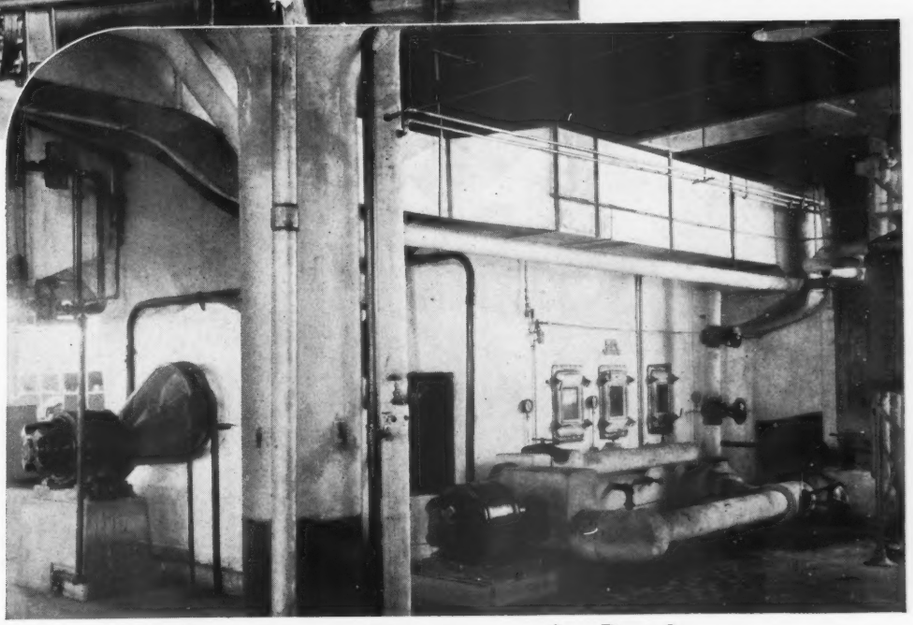
PHARMACEUTICALS
REFRIGERATORS

★



It's not the heat but the relative humidity in tablet polishing. Conditioned air (Carrier) delivered to battery of polishing kettles at Parke, Davis Company, Detroit, insures regular production, uniform product . . . Kelvinator Corporation solved problem of humidity control in production of rotary-type condensing units by installing its own air conditioning equipment. Special room is sealed against temperature and humidity leaks, even has double doors





Behind the scenes at Kelvinator and Parke, Davis. Former has a 10-hp. condensing unit located outside the sealed assembly room. Latter's dehumidifier has three banks of sprays; practically all air handled is fresh air except that returned from polishing room

Air Conditioning . . . . . for People, for Products, for Profits

KEEPING AIR FRESH

AIR IN any occupied area tends to become heated and vitiated through the introduction of gases, odors, dust, and so on. When a comparatively few persons occupy a large area and there is no other source of pollution, vitiation of the air is slow and may be counteracted by natural infiltration of outside air. If the area is crowded or certain kinds of processes are carried on, accumulation of heat and impurities may be rapid and require artificial means of keeping the air fresh, by replacing it with fresh air from the outside.

Two potent natural forces—wind and the difference in temperature between inside and outside air—work toward the replacement of air in a building. Wind ventilation tends to produce horizontal motion of the air, whereas in ventilation through temperature difference the air motion is largely vertical.

The efficiency of natural ventilation can be increased and a weathertight exit for the air provided by the use of a roof ventilator, of which there are various designs. Aside from giving the vitiated air a means of escape, some roof ventilators are designed so that wind blowing over them produces an aspirating effect.

Also available are roof ventilators with built-in, motor-driven fans. These outfits are coming into favor, since they combine the advantages of continuous service with low installation and operating cost.

Ample Inlets Needed

For maximum efficiency, ventilators should be placed on the roof in locations where they will receive the full force of the wind. When they are shielded by obstructions the capacity is reduced.

Effective operation of roof ventilators also depends on the provision of ample air inlets. The area of such openings, which are placed at low levels in the building, should not be less than the combined throat area of all roof ventilators. It is advisable for the inlets to have twice the area of the ventilators.

When for any reason it is not desirable or possible to install the conventional type of roof ventilators, ventilating fans may be built into outside walls and used to force the air out. They may also be used to draw fresh air into the area.

Air Conditioning in industry is growing in importance because of its effect on people, products, and profits. It must be considered as one of the essential tools of modern plant operation

In some instances fresh air is injected into the area at high velocity through nozzles.

Although the arrangements described above are sufficient to keep the air of an area in good condition under any ordinary circumstances, there are many operations, such as buffing and grinding, electroplating, pulverizing, and so on, in which large quantities of dust, gases, or fumes are given off. It is desirable, may be necessary, to remove these impurities before they become disseminated throughout the work area. For this purpose some form of exhaust system is used.

Which Exhaust System?

Several different arrangements are commonly employed, but they fall into one or the other of two general systems—the central and the group. In the central system a suitable fan is placed about the center of the area, with a system of ducts radiating to the various machines. When the machines or equipment is scattered over a large area, the group system may be used. In this arrangement individual fans are located at each machine or group of machines and serve to draw off the dust or fumes.

In many instances an open hood placed over or close to the equipment will suffice to remove practically all the dust or fumes, when these are lighter than air. Such hoods must be placed as close as possible to the source of the contamination, although a large enough opening must be left to permit the flow of sufficient air to carry off the offending material.

When the fumes are heavier than air, horizontal or floor ducts are required. In any event, the volume and velocity of the air must be sufficient to prevent diffusion of the fumes through the air of the room, or at least keep it down to a minimum.

Sometimes it is feasible to build a reasonably tight inclosure around dust-producing equipment. Maintenance of a slight suction or negative pressure within the inclosure will cause inward rather than outward leakage of air, and thus prevent the escape of dust.

For many applications, however, it is desirable or necessary to use other means of ventilation than those described. Then unit ventilators or a central fan system may be used.

Unit ventilators contain a fan, heating element, air-mixing chamber, and temperature control devices. An air filter may or may not be included. Provision is made for taking all or any desired proportion of the air from outdoors.

Better Temperature Control

In central fan systems the air is distributed through ducts. Such systems may be operated in several different ways. For example, heating may be done by local radiators, a fan being used only for ventilation, some of the air being drawn from the outside. Or part of the heat may be supplied by radiators and part by the fan system. This method has certain advantages, among which are less danger of uncomfortable drafts and better temperature control. Again, all the heating may be supplied from the fan system.

With the central fan system the air can, of course, be further conditioned in any way desired.

HOW AIR IS COOLED

THERE are several methods of cooling air, the choice depending on the purpose or reason for doing so, and on the amount of cooling necessary. In comfort cooling we are concerned primarily with the *effective* temperature, whereas in cooling for process work it is required to make the air actually cooler, rather than to make it seem cooler. It must be kept in mind, too, that there is a very close relationship between cooling and dehumidification, or removal of moisture from the air.

The effective temperature of air can be lowered (1) by increasing air motion; (2) by removing part of the moisture content without changing the dry-bulb temperature; (3) by lowering the dry-bulb temperature by evaporating moisture, without adding or taking away heat; (4) by removing heat and thus lowering the dry-bulb temperature.

The first method increases evaporation of perspiration from the skin by bringing a greater volume of air in contact with it, and also tends to remove heat from the skin and thus make us feel cooler, although the actual temperature is not changed.

The next method, dehumidification, will be discussed in the succeeding section. Lowering the humidity of the air increases the evaporation of perspiration, with cooling effect.

When Air Is Very Dry

Lowering the dry-bulb temperature by evaporating moisture, method 3, is brought about by passing the air through a spray of water which is continuously recirculated. Entering the spray chamber in an unsaturated condition, the air evaporates some of the water and thus loses part of its sensible heat. The dewpoint (temperature at which moisture will condense out of the air) rises, and the dry-bulb temperature is lowered to the point of saturation.

It is easy to see that the temperature of the air leaving the spray chamber depends entirely on the wet-bulb temperature of the air as it enters the spray. Obviously, evaporative cooling, as this process is called, is effective or satisfactory only when the air to be cooled is very dry. However, it is much more dependable and will decrease the effective temperature to a greater extent than air motion alone.

Over Cold Coils

Cooling of air by removing some of the sensible heat is in general accomplished by passing the air over cold coils or other surfaces. These cooling elements are chilled in turn by passing cold water, brine, or some refrigerant through them.

When an ample supply of cold water is available it may be circulated through coils over which air is passed.

Ice is sometimes used for cooling air. Lowering of the temperature may be brought about by blowing the air over the ice, or over metal surfaces in contact with it.

In large installations water from a tank containing ice is circulated through air-cooling coils.

These methods are more or less effective and have the advantage of simplicity and low first cost. Operating cost is comparatively high.

Usually mechanical refrigeration is employed to produce the low temperature required for cooling air. Mechanical refrigerating machines are of two general types—compression and absorption. In the compression-type machine the refrigerant, in the gaseous state, is put under considerable pressure and passes to a condenser where it is cooled and then collects as a liquid in a receiver. From there it flows to an expansion valve through which it passes into the evaporator coil at a rate that is slow enough to maintain a low pressure.

Under the low pressure in the evaporating coil the liquid refrigerant changes to the gaseous state and in so doing absorbs heat from whatever medium (air, water, brine) surrounds the evaporator coil. The refrigerant then passes to the compressor and the cycle is repeated.

Steam jet compressors also find application in air conditioning. These compressors operate on the principle that water vaporizes at low temperatures, under high vacuum. Water to be cooled is sprayed into the cold tank or evaporator of the machine, in which the pressure is kept at a very low point by a steam jet. Under the low temperature the water boils and part of it is converted into vapor, lowering the temperature of the remainder.

Cooling by Absorption

Absorption refrigerating systems are not so widely applied to air conditioning as the other types described. Ammonia is usually the refrigerant. The gas is absorbed in water and then pumped to the generator, which contains a steam coil. Heat from the latter drives off the ammonia gas which then passes to the condenser, where its latent heat is removed. From the condenser the refrigerant, now in liquid form, flows to the receiver and then through the expansion valve to the evaporator. Passing to the gaseous state it absorbs heat from the medium surrounding the evaporator coils, then returns to the absorber.

In central fan systems the air, after being cooled, is distributed through ducts. In order to reduce cost of operation, provision is usually made for recirculating all or part of the cooled air from the conditioned area.

Portable, self-contained cooling units are also available. These contain a motor-driven compressor, fan, and expansion coil, and can be arranged to take the desired amount of air from the outside. The advantages of these units are their portability and cheapness of installation.

In the first ten months of 1935 the value of Air Conditioning equipment orders booked rose 19 per cent over the same period of 1934, and 101 per cent over corresponding months in 1933

RAYON

GLUE

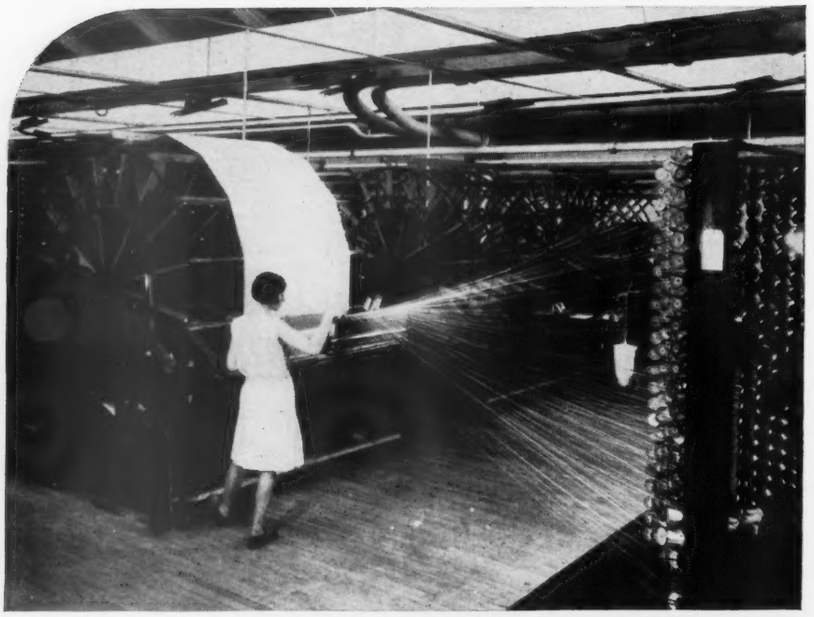
LEATHER

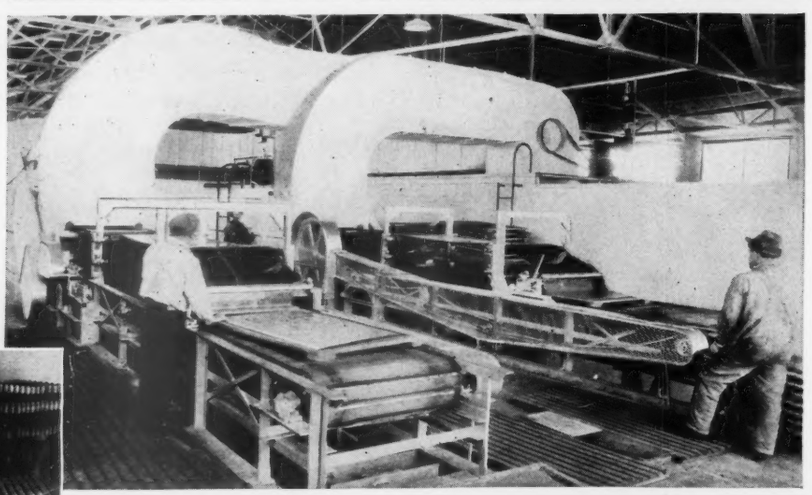
DRUGS

CANDY

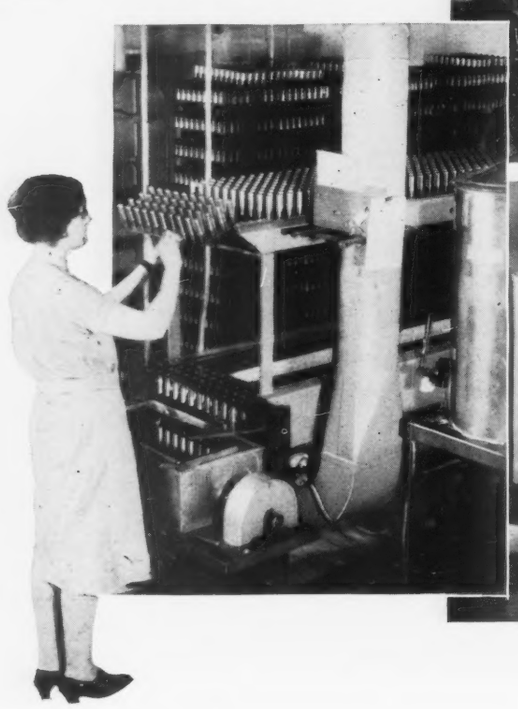
NEWSPAPERS

ICE CREAM





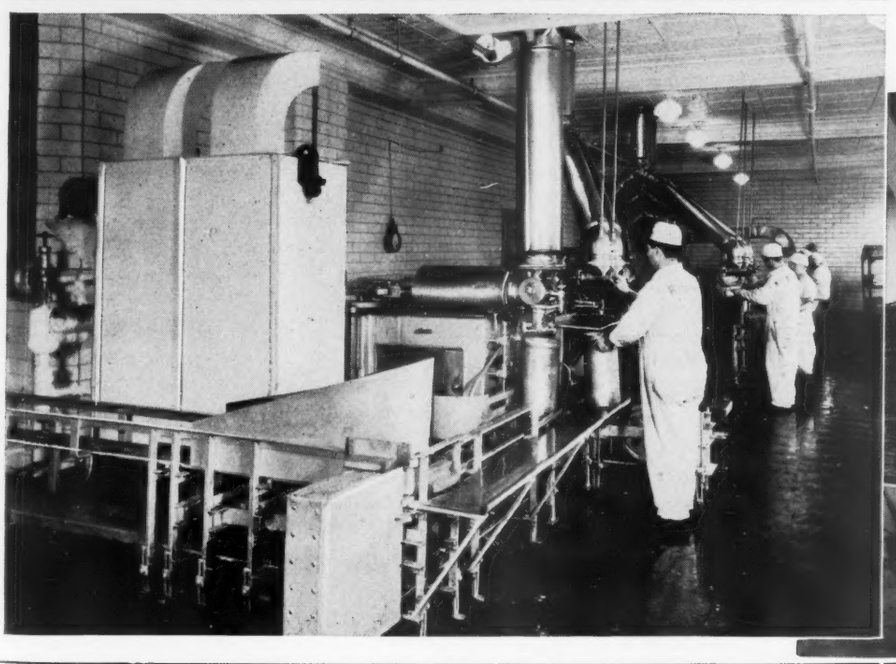
Parke, Davis safeguards capsule manufacture with an air conditioning (Carrier) installation



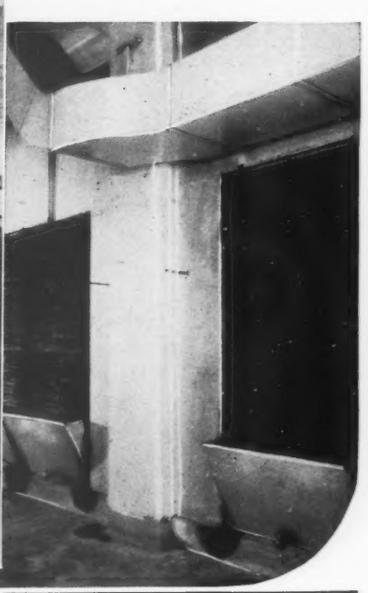
Air conditioning is practically a "must" in plants like these . . . Viscose Company of America, Marcus Hook, Pa. (Carrier) . . . Pacific Bone, Coal & Fertilizer Company, Bayshore, Calif. (York) . . . Lang Tanning Company, Kitchener, Ont. (Frick)

Air Conditioning ..... for People, for Products, for Profits

Air conditioning regularizes the production of hard candies at W. F. Schrafft & Sons Corporation, Boston (Carrier) . . . makes life worth living in the Tampa Tribune's linotype room (York) . . . insures continuity of production and a quality product at Riech McJunkin Dairy Company, Pittsburgh (York)



Air filters (American) supply clean make-up air for spray booths in the finishing department of an electrical appliance manufacturing plant



TO REGULATE HUMIDITY

AIR ALWAYS contains some moisture, but the amount varies widely with the temperature, season of the year, location and so on. Sometimes it contains too much moisture for either comfort or the successful conduct of manufacturing operations; at other times it contains too little. Hence it is frequently necessary to humidify or dehumidify the air of work places and other areas.

How to Humidify

In general, air may be humidified (1) by introducing water into it in the form of a fine spray or mist; (2) by passing the air through a spray of water in an inclosed chamber.

Direct humidifiers employ several different methods of forming a spray. Atomizing sprays, of which there are several types, utilize compressed air at about 30 lb. per sq.in. to produce, direct, and distribute the spray.

In high-duty humidifiers a jet of water under a pressure of 150 lb. per sq.in. strikes against a small projection and is broken up. A fan mounted over the unit forces a current of air through it, which evaporates and distributes the spray.

Spray humidifiers comprise an impact nozzle in a cylindrical casing. The spray is distributed by an air current formed by the aspirating effect of the nozzle.

Another type of humidifier, the centrifugal, is capable of forming and distributing spray without the use of auxiliary air compressors or pumps.

These humidifiers may be used alone or in combination with other air conditioning equipment. Direct humidification is usually most satisfactory when high degrees of humidity, but little ventilation or air motion, are needed.

In central air conditioning systems the air is washed and humidified at the same time, by forcing it through an air washer. A washer is essentially a chamber built of sheet metal or wood. Air to be conditioned is forced through this chamber and brought into intimate contact with water by having it go through a spray or pass over surfaces over which there is a continuous flow of water. To insure proper operation, provision is made for an even distribution of the entering air, and baffle plates whose function is to remove any water in suspension are placed at the outlet.

Scrubber-type units, in which the air passes over wetted surfaces, are supplied by flooding nozzles, spaced on about 1-ft. centers at the top.

In spray-type washers, water is delivered through atomizing nozzles, commonly arranged in banks across the washer. Direction of spray may be either with or against the direction of air flow.

Contrary to what might be thought, an air washer can be operated to add moisture to or remove it from the air. When the water is neither heated nor cooled, the air tends to become saturated at its entering wet-bulb temperature, and the dry-bulb temperature drops in proportion to the amount of water evaporated. This process, known as evaporative cooling, was mentioned in the preceding section.

Heated or Cooled

If, now, the water in the washer is either heated or cooled, heat is exchanged between the water and the air, and the latter tends to become saturated at the temperature of the water as it leaves the washer. The air will be raised or lowered in temperature depending on whether the water is of a higher or a lower temperature than the wet-bulb temperature of the entering air.

Heating or cooling of the water for an air washer is a comparatively simple matter. To heat the water it is usually passed through closed hot water heaters; or steam may be injected into the water circuit. For cooling, the water is passed through a cooler, which is kept at the desired temperature by refrigerating coils.

Dehumidification by refrigeration, in which the air is cooled below the dew point with the result that part of the moisture condenses out, is widely used. There are, however, two other methods of removing moisture from air—adsorption and absorption.

Adsorption refers to the property of certain substances to condense a gas or vapor and retain it without any change in the physical or chemical structure of the substance. In absorption there is a change in the chemical or physical structure of the substance.

Blotters for Moist Air

Silica gel is one of the best-known agents used in the adsorption process. It is hard and glass-like with the same chemical composition as silica sand. Of porous structure, it has the property of adsorbing or removing water from air in contact with it. When it has taken up all the water it can hold, it can be reactivated by heating.

In a silica gel system, beds of the gel are arranged to be used alternately. When one has become saturated with water it is taken out of service and air at approximately 300 deg. F. is passed through it.

Activated alumina, an oxide of aluminum, is another solid material that has strong affinity for water and may be used in place of silica gel for dehumidification. It also can be reactivated by the application of heat, and in general is used in essentially the same way as the silica gel.

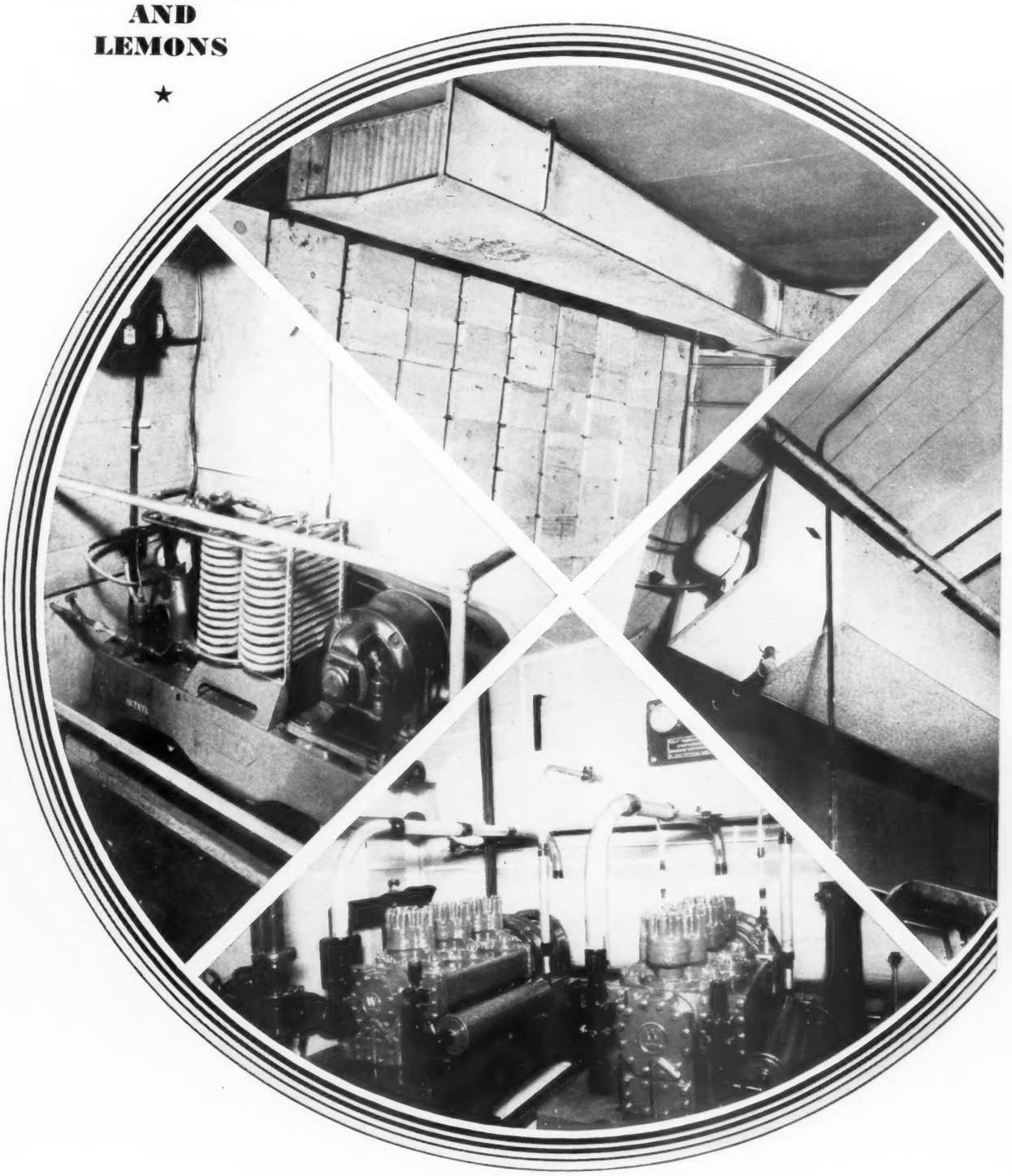
When dehumidification is accomplished by refrigeration, the temperature of the air is lowered; when air is freed of its water by silica gel, the air is heated and therefore may require cooling. Also, the humidity is reduced to a very low value; it may therefore be desirable to mix fresh outside air and that which is recirculated from the conditioned area with it, in order to raise the humidity to a desirable value.

In some industrial applications very low humidities are desired; in such instances the silica gel or activated alumina systems are particularly suitable. For ordinary installations the choice of the dehumidifying system to be used must depend on the requirements and on certain economic factors.

★

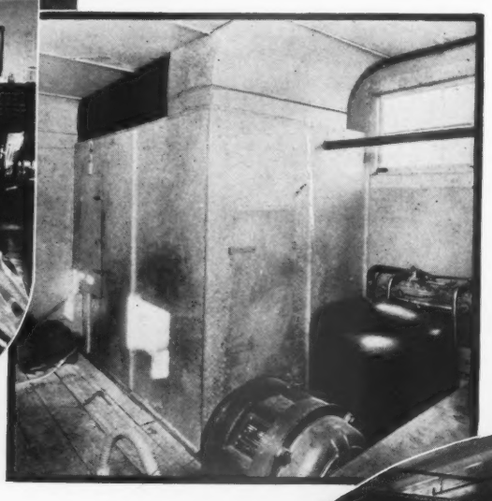
LITHOGRAPHING AND LEMONS

★



North and south, delivery and business ends of a fruit pre-cooling installation (Westinghouse) at the LaVerne Lemon Growers Association, La Verne, California . . . east and west, ceiling-type cooling unit (Ilg) with remote compressor installed at the Robert Teller Sons & Dorner plant in New York, whose business is steel etching and color lithographing, hence maintains relative humidity of 45 per cent so that production will not be interrupted on muggy days

Air Conditioning . . . . . for People, for Products, for Profits



★

PLANT OFFICE AND PAPER STORAGE

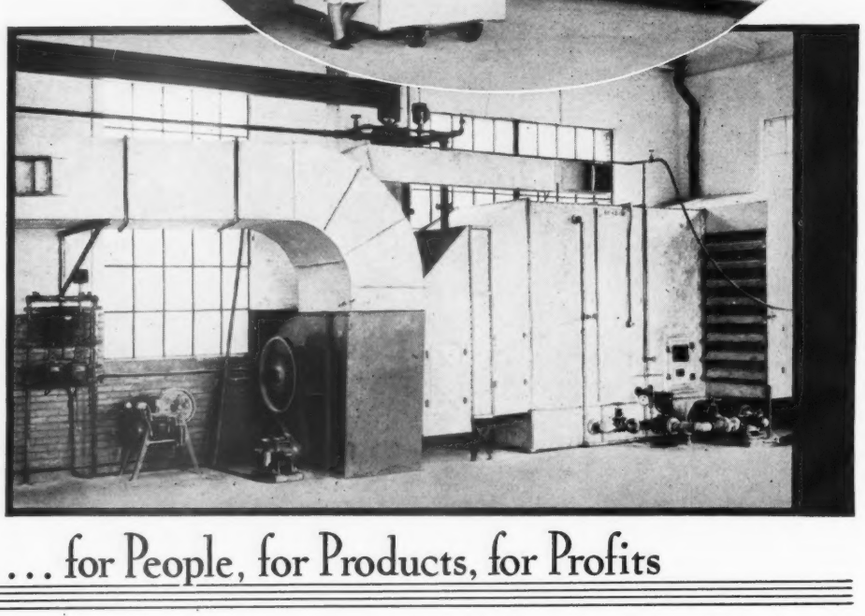
Ninety in the shade outdoors, but office employees of Campbell-Taggart Associated Bakeries, Kansas City, are cool as the proverbial cucumbers. Only excuse for air conditioning (General Electric) the plant office is to make it a better place to work in. Better excuse is never needed

•

Paper is one of those exasperating materials labeled hygroscopic. That is to say it is subject to the vagaries of the weather. Hence we find paper manufacturers, among them P. H. Glatfelter Company, Spring Grove, Pa., taking steps. This is a view of that concern's paper stockroom where humidity and temperature are closely (York) controlled

•

Equally important in paper manufacture is control of dust. The Glatfelter concern avoids a pepper-and-salt effect by washing the air before ever it is delivered to production departments. A view of the air washer



Air Conditioning ..... for People, for Products, for Profits

LAUNDERING AIR

AROUND industrial regions and in cities the air almost always contains a considerable amount of soot and other solid matter commonly termed dust, which is of extremely diverse character and origin. Removal of these impurities is an important matter from the standpoint of health and may be highly desirable or necessary for the efficient conduct of manufacturing processes.

Two general schemes are in use for removing solid impurities from air: (1) By passing it through an air washer; (2) by passing it through some kind of filter.

Air washers, in which the air is passed through a spray of water or forced to travel over wetted plates, were described briefly in the preceding chapter in connection with regulation of the moisture content. These devices, therefore, perform a dual function.

Considered as a means of removing impurities from air, an air washer does not in general function so efficiently as a filter. Its effectiveness in removing fine dust of a greasy nature, such as soot, is very slight; the same thing is true of its deodorizing ability.

Filters, Viscous and Dry

Air filters are available in two general types, the viscous and the dry. The principle of operation of the viscous type is to have the stream of air strike a large number of surfaces coated with some material that will trap and hold any particles of dust that strike it. Therefore, the filter consists of a layer of some such material as steel or glass wool held in a suitable frame. The filtering medium is usually coated with an oil. In passing through the filter the air is broken up into innumerable fine streams, which is a prime requisite for effective cleaning.

Commonly these filter units are made of a size that is convenient for handling. Therefore a complete installation consists of as many units as are necessary to give the required capacity. The frames of the units are fastened together so as to form a partition between the dusty air and the fan.

Any filtering medium interposes some resistance to the flow of the air. In the viscous type the resistance of a well-designed unit depends primarily on the velocity of the air and the amount of dirt in the filter. As the filter becomes increasingly dirty, the resistance to air flow goes up. Normally the effectiveness of a filter reaches a maximum after it has been in use for a sufficient time to permit some dust to collect in the air passages, where it serves to arrest other particles.

Keeping Filters Clean

Eventually filter cells become so clogged with dirt that the air resistance is excessive, and they must be cleaned—or thrown away. To avoid the bother of cleaning, inexpensive units have been designed that have about the same operating characteristics as the more strongly built type, but are cheap enough to warrant discarding when they become too dirty.

The automatic type of viscous filter is self-cleaning. Dust removal is accomplished in the same way as with the unit type. Cleaning is based on the principle of having the viscous material perform that function. The dirt removed from the air accumulates at the bottom of the tank and is removed from time to time.

Several different designs of automatic or self-cleaning filters have been developed. In one type the filter medium is made in the form of an endless vertical curtain which is rotated slowly with the lower end dipping into a reservoir of the coating material. In passing through, the filter is cleaned and recoated.

Another form of automatic filter has the screen designed in the form of shelves or cylinders. These are kept clean by forcing the liquid through them in the opposite direction to the air flow.

A third type of filter is made in which the medium is vertical and stationary. The coating fluid is poured over it from above, the flow of air being stopped meanwhile.

With the latter two types of filters the cleaning and coating process is intermittent. An electric motor controlled manually or by automatic timing devices usually furnishes the power.

Dry-type filters consist of a suitable frame containing a screening material such as cloth, cellulose paper, or felt. As the name indicates, the medium is not coated with liquid, and removal of dust from the air is accomplished by the screening or straining effect of the medium. In order to remove dust effectively, the filter medium must be of close texture, which results in a comparatively low air velocity. It is therefore necessary to have a large surface area; so the filtering medium is usually arranged in the form of pockets to increase the surface of a given face area.

When felt and similar materials are used as the filter medium, vacuum cleaning is used to recondition them. As in the viscous type, some dry filters are designed to have the dirty filter medium discarded and replaced with a clean sheet.

Avoid Overloading

Satisfactory cleaning of air depends on a careful selection of the filter as to size and suitability for the requirements and operating conditions. Filters should not be called upon to handle very much more than rated capacity. If the filter is too small, increased dust loading due to the greater air volume handled makes it necessary to clean or renew the filter more frequently. Furthermore, the resistance of the filter is higher.

To avoid overloading some units of a large filter and underloading others, it is necessary to secure even air distribution across the face of the filter. Best results are obtained when incoming air enters the chamber perpendicular to the filter. Since normal air velocity in ducts is several times that required at the face of air filters, either the duct must be enlarged or the filter installed diagonally in the duct. Enlarging the duct usually gives the best results, provided it is done gradually.

WEATHER WATCHDOGS

EVEN though equipment of proper type, quality, and capacity may be assembled for the job of conditioning air, satisfactory performance cannot be expected unless suitable controls are provided. These controls must be capable of adjusting the capacity of the system, which is designed for maximum conditions, to the widely varying intermediate temperatures and humidities prevailing 90 per cent of the year. Proper control not only avoids waste of refrigeration and heat, but also prevents excessive temperature changes with resultant discomfort and ill health.

For Winter, for Summer

Where complete air conditioning is installed, the controls must take care of both winter and summer conditions. Thus for winter operation controls must be provided that will turn steam on and off to heating coils. For summer operation the temperatures of the air washer spray or cooling coils must be adjusted to give the required humidity, and the dampers must be operated to control the amount of air bypassed, the amount of fresh air intake, and the return air exhausted.

The primary elements of air conditioning control are thermostats which are sensitive to dry-bulb temperatures, and humidistats which are sensitive to relative humidity or wet-bulb temperatures. These primary instruments may operate valves and damper motors either electrically or through the medium of compressed air. They may be either quick acting, in which case the controlled valve or damper is either wide open or closed, or gradual acting, in which case the controlled valve or damper may be held in any partly open position required.

In general, electric control is used for small installations, whereas either air or electric operation may be used for larger installations.

It is dewpoint temperature that determines the amount of moisture in the air; so in air conditioning systems employing air washers the desired humidity is obtained by controlling the temperature of the spray water, which in turn determines dewpoint temperature. If the temperature of the spray water is regulated so that air leaves with a dewpoint of, say, 45 deg. F., it will have a relative humidity of 40 per cent when heated to a room temperature of 70 deg. F. Therefore, to control humidity, a gradual-acting thermostat is often placed at the exit of the air washer and arranged to control a valve which starts to admit refrigerated water to the suction of the spray water pump when the exit air temperature rises above the required dewpoint.

A humidistat which responds directly to changes in humidity may be used to control the dewpoint, instead of the thermostat at the air washer exit. The humidistat is, however, placed in the conditioned room or in the path of the return air leaving the room. A combination wet-bulb and dry-bulb thermostat may also be used.

With usual room conditions, saturated air will have a relative humidity of approximately 50 per cent when its temperature is raised 20 deg. F. Therefore a differential thermostat consisting of one element in the path of the air leaving the air washer and the other in the room can be made to maintain a nearly constant relative humidity by keeping dewpoint temperature 20 deg. below room dry-bulb temperature.

With Air Washers

When relative humidity is controlled with air washers, the air must be reheated before it can be supplied to the conditioned space. This may be done with return air bypassed around the air washer or by reheating with steam coils, by a combination of both methods.

When bypassing is used, a gradual-acting thermostat is usually placed in the duct after the supply fan and arranged to open bypass dampers and close recirculation dampers when the temperature falls below the thermostat setting.

If reheating coils are used, a 1- or 2-point quick-acting thermostat should be used to open the steam inlet valves to the reheating coils. The thermostat may also be arranged to operate a damper in a bypass around the reheating coils.

For winter operation, quick-acting thermostats are installed to control valves supplying steam to tempering coils in the fresh air inlet. Various arrangements may be employed here, but in most of them a thermostat is arranged to open the valve to the first tempering coil when the outdoor air temperature falls below about 35 deg. F. As the outdoor temperature decreases, additional tempering coils are put in operation either by the thermostat or humidistat used to control humidity, or by a thermostat at the air washer inlet, if the spray water is heated with steam.

Summer vs. Winter Practice

In winter, room temperatures are maintained constant when occupied, but in summer it is desirable to let the indoor temperature increase as outdoor temperatures increase, in order not to have too great a differential. To accomplish this may involve manual setting of the thermostats; or it can be made automatic by using a gradual-acting thermostat in the fresh air intake to reset a thermostat in the return air duct 1 deg. for each $2\frac{1}{2}$-deg. change in the outdoor temperature. This thermostat is used to reset the thermostat in the supply fan discharge in inverse ratio by an amount established by design.

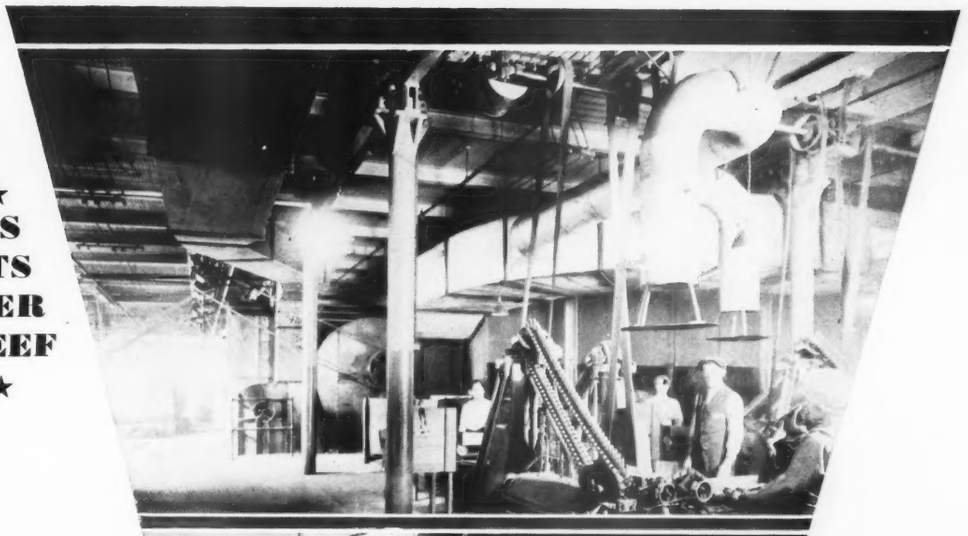
It should be noted that when a central air conditioning system serves several rooms having different rates of heat gain or loss, different room temperatures will result unless the volume of conditioned air supply is controlled, or individual heaters or coolers are provided to make up the difference.

Similarly, if water vapor gain or loss varies in the conditioned spaces, different relative humidities will result unless independent humidification or dehumidification is provided. This fact is particularly important in industrial air conditioning installations because of the varying amounts of heat and moisture gain in different factory departments.

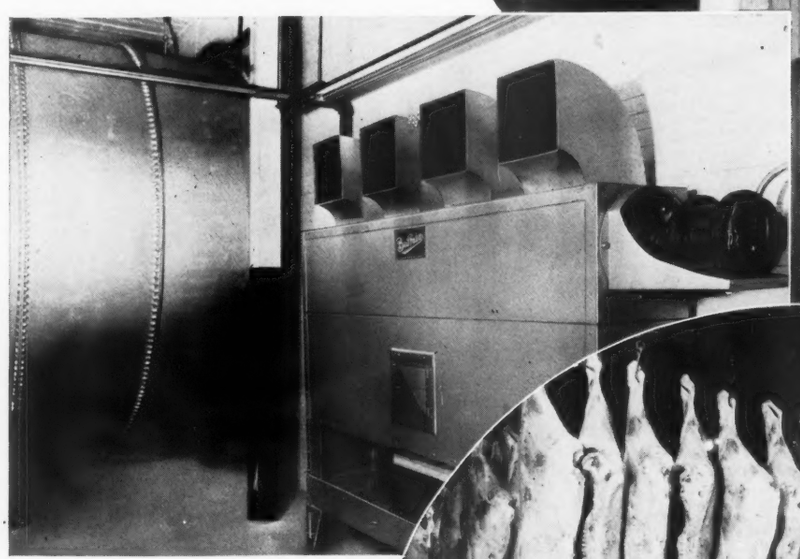
★

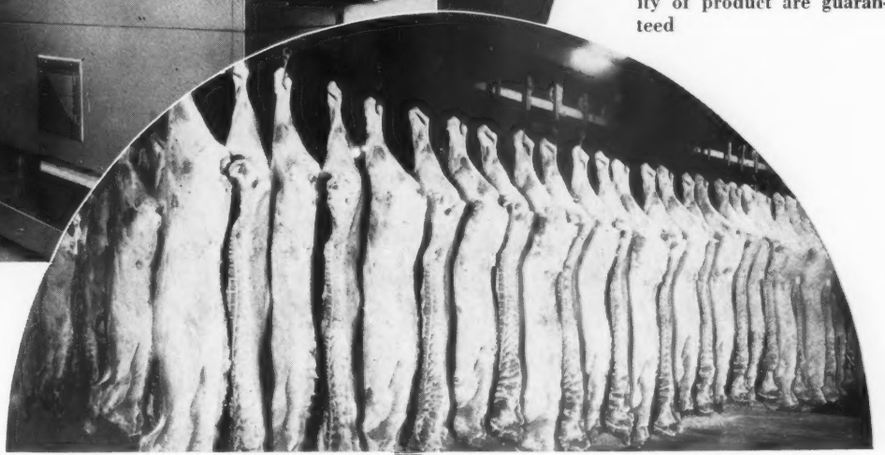
CIGARETTES
AUTO PARTS
BEER
BEEF

★



Air conditioning is no respecter of industries. We find it (Parks-Cramer) in the St. Louis factory of Liggett & Myers Tobacco Company, where constant temperatures play an important part in conditioning the raw materials, and (Trane) in an automobile accessory plant, where the problem is to speed up lacquer drying without damaging finishes and where humidity must be controlled within close limits at extremely high temperatures





Beef and beer must be kept in coolers, or else—. Hence a cooling unit (Buffalo Forge) in the storage basement of Peerless Brewing Company, Washington, Mo., and a beef cooling room (Frick) at The Canadian Abattoir, Toronto. In either case, quality and uniformity of product are guaranteed

Air Conditioning ..... for People, for Products, for Profits

WHERES AND WHYS

MENTION has been made in preceding chapters of the fact that a large number of industries have found it profitable, sometimes necessary, to use air conditioning for one purpose or another, and that there are probably several hundred manufacturing operations in which close control of atmospheric conditions is either highly desirable or essential for efficient production. The fields that some of these industries cover, and the purpose for which they condition the air in various departments are shown by an investigation made by the Edison Electric Institute.

This study revealed that air conditioning is being used in one or more plants in the following industries, and for the reasons indicated:

Bakeries—In three instances it is used in dough rooms and proofing rooms to give a better product and uniform, controlled production.

A manufacturer of fancy cakes greatly reduced production time, cut costs, and improved the product.

A Midwestern bakery uses artificial cooling for the mixing room and for cooling bread after baking.

Candy — One manufacturer finds that air conditioning prevents loss of product by spoilage, and insures uniformity and increased production.

Two plants find that it facilitates hardening of the product, cleanliness in wrapping, and employee efficiency.

Special conditions were required in one plant for coating candied nuts.

For an Eastern manufacturer it insures quick hardening of chocolate and preservation of candy during the summer.

Air conditioning enables another Eastern concern to manufacture chocolates in summer, when such plants are ordinarily closed down. It is also used in starch rooms, enrobing or coating rooms, storage and packing departments, and in the company offices.

Chemicals and Drugs — Manufacturers of hygroscopic chemicals or drugs have to maintain close control of humidity in order to prevent spoilage of the product.

Collapsible Tubes — An Eastern manufacturer conditions air primarily to make his plant a better place to work in; finds he safeguards painting processes, insures quality product.

Creameries — A Midwestern concern uses artificial cooling for the butter wrapping room. Another conditions the air in order to maintain suitable working conditions.

Fruit Ripening — Two companies condition the air in rooms for ripening bananas, to reduce spoilage and control the ripening period.

Food Specialties—A manufacturer of a gelatin-base dessert found that dehumidification of the air was necessary.

A producer of shelled pecans requires low humidity to prevent spoilage and improve the quality of the product.

Leather—A tannery uses air conditioning in the hide storage cellars.

Meat Packing—An Eastern plant finds that air conditioning improves its sausage product.

Another plant maintains high humidity for processing hams and sausage.

Air conditioning prevents shrinkage and loss of weight, and gives improved appearance to the products of a New York State packer.

Photographic Film — A large manufacturer uses air conditioning in connection with the manufacture of film and positive papers; also, to set emulsions and insure clean air under constant conditions for process cooling.

Printing and Lithography — One plant in the Middle West conditions the air to facilitate production and improve quality through better drying of the ink, elimination of static electricity, cleaner air, and removal of heat from type melting.

It maintains the proper humidity for accurate lithographic reproduction in two plants.

Another makes use of humidification and air circulation to eliminate static electricity.

In an Eastern establishment humidity is controlled to prevent paper stretching and shrinkage and thus insure register.

A Maryland printer prevents expansion and shrinkage of the wooden blocks on which line cuts and halftones are mounted.

Textiles — A manufacturer using rayon yarns conditions the air to prevent stretching of the threads, thereby eliminating seconds and spoiled product. Formerly it was impossible to carry on manufacturing operations successfully during the summer.

In the Southwest a manufacturer of cotton products wants to maintain a humidity of 45 per cent—and does it.

For a silk manufacturer a relative humidity of 75 to 80 per cent facilitates production and insures better quality.

Tobacco and Cigars — Air conditioning gives an Eastern manufacturer closer control over curing and process operations, permits working of tobacco regardless of weather conditions. Results are a better and more uniform product, increased efficiency, and reduction in time lost by employees.

A Southern manufacturer uses it to improve the working qualities of tobacco and for special processing to give a better product.

Telephone Cable—To maintain extremely low humidity in rooms where the cable is covered, so as to eliminate any trace of moisture in the finished product.

Cork Products — A bottle cap manufacturer conditions the air in rooms where specially prepared sticks of granulated cork are handled, in order to prevent the binder from softening.

Sugar Storage — For a Southern manufacturer air conditioning reduces storage losses and improves the quality of the product.

Fruit Storage—It enables a producer of citrus fruit to hold his stock until satisfactory market conditions prevail.

Rayon Manufacture — Air conditioning is used throughout one plant. Practically all the air that comes in contact with the product in its various stages is conditioned.

Miscellaneous — A mushroom grower maintains, artificially, a relative humidity of 70 per cent, and a temperature of 70 deg. Fahrenheit.

Air conditioning enables a curing room for cement testing to be kept at a temperature of 70 deg. F. and 98 per cent relative humidity.

Factory MANAGEMENT AND MAINTENANCE · Plant Operation Library

Employee training

AUTHOR
H. P. DUTTON
Associate Editor

Chapter 1. Today's Need for Training.....S182
Chapter 2. How a Man Learns.....S183
Chapter 3. What Is to Be Taught?.....S186
Chapter 4. What Type of Instruction?.....S188
Chapter 5. Teaching Procedures.....S193
Chapter 6. Six Typical Training Plans.....S196

CHAPTER ONE

Today's Need for Training

ALTHOUGH business is improving, general labor shortage still seems a far cry from reality. Yet it is a fact that distinct shortages are developing in certain lines, such as skilled metal workers, for instance. Foresighted employers are also rapidly waking up to the fact that, if the improvement in business continues, it is presently going to be difficult to supply *skilled* workers in many other lines and particularly to develop men for promotion. An active movement seems therefore to be under way to take on as learners in routine positions, and usually for very moderate salaries, the more promising of the young men at present unemployed or unsatisfactorily employed.

It would not take a very great increase in business to swing the labor market over, with some suddenness in certain lines, from the glut of the last five years to the scarcity that employers in 1919 and 1925-27 can well remember.

As regards many particular lines, the present reality of an oversupply of labor is likely to disappear on closer analysis. Of the men laid off years ago and held on the waiting lists for future employment, it is the experience of many employers that only a minority, and those not the best, are still looking for jobs. Most of them have made other connections. Many of them are now old men. Some of them have adjusted themselves to living on savings or odd jobs or with relatives, and will never work again. Of the large number on relief, probably at least 2,000,000, not including their dependents, are normally unemployable except for odd jobs and during periods of severe shortage of men. Many others are agricultural workers.

More Mechanization

There are thousands of young people, graduates of our schools and colleges, who are still living at home and doing odd jobs, but most of them have had no systematic training in any trade or business; many of them have suffered the partial demoralization of working habits that comes from idleness and uncertainty of purpose.

It is likely to be a long time before this host of the unemployed is fully absorbed by private industry. Indeed, so far as my own observations extend, the mechanization of industry is proceeding at as rapid a rate now as at almost any time in the past. The availability of cheap capital and the attempts, justifiable during the emergency, to keep up wages, have shifted the cost balance in favor of further mechanization.

The answer in our past to the employment of the people displaced by technological advances, has been new industries. Until such an industry emerges, or until some other way is found of giving people work, there is likely to be no general labor shortage.

•

COVER PHOTOGRAPH

Key men at the Hobart Brothers Company, Troy, Ohio, receive special training in cooperation with the State Board of Vocational Training

•

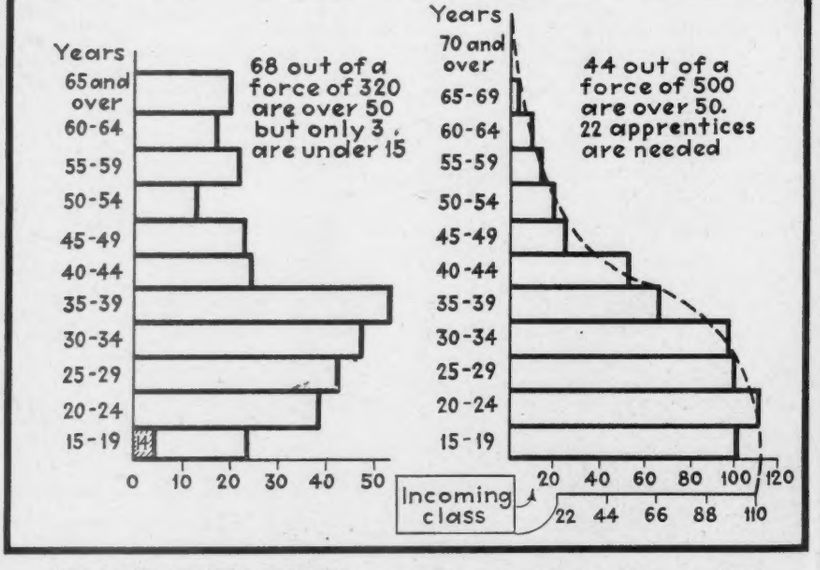
To an extent unparalleled in our history, however, most unemployed workers must now be considered unskilled. For five years the training of new workers has almost ceased. For five years thousands of men who knew their trades have been unable to practice them, to retain and exercise the skill they once possessed. In some cases this skill is now partially or wholly useless, because of changes in technical methods in which the worker has had no opportunity to participate.

If He Lasts

Aside from the obvious probability of shortages of skilled workers, likely to develop at any time, there has never been in our industrial and national life a sufficient appreciation of the importance of thorough training. Chance throws a man into an occupation. Without any but the slightest foundation, and often with only the most casual demonstration of the required technique, the new man is left to pick up his trade skill and understanding as best he may.

By criticism and hard knocks he does, of course, eventually acquire some sort of proficiency if he lasts that long. But the world is full of men who seldom hold a job more than a year or two. Often the difficulty lies in fundamental instabilities and weaknesses of the individual. Perhaps oftener than we realize, the truth is that the man, led either by the optimism of ignorance or by necessity, is attempting jobs whose fundamental requirements he does not understand.

A large part of this waste could



WHY NOT DRAW A PICTURE representing conditions in your own plant? (The one above was drawn by the German Dinta, and published in American Machinist.) It will show about how much longer you can count on your old employees, and what arrangements you must make to fill vacancies through promotions or additions

be avoided were we to abandon the attitude that resourcefulness takes the place of skill. The results of that attitude are apparent in all too many phases of American life. In politics, for example, persuasiveness and ability to get out the vote are too often substituted for professional competence, with disastrous results.

In part this improvising approach is a consequence of the constant change and evolution characteristic of industrial life, which may at any time render an acquired skill obsolete. But the best foundations for re-learning a trade are skill and a knowledge of what constitutes good workmanship in some other trade. And the answer to technical trade changes should in most cases be neither obsolescence of the worker nor crude and costly undirected learning, but a systematic and rapid instruction of the worker in the elements new to him in the new technique.

There is a very definite relation between skill and morale. The competent man finds pleasure in his work, feels a reasonable security in the knowledge that, as one old glass-cutter put it, "a man who has a trade can live anywhere."

Beset by Insecurities

On the other hand, the man who has not been taught his work but has had to pick it up by observation or by haphazard assistance from men little if any better informed than himself, is beset by insecurities. He learns to "get by"; he may even in time dig out for himself real competence and knowledge of fundamentals. But too often the man is continually under a pressure, of which he may not himself be aware, to cover up deficiencies by directing attention elsewhere.

Sometimes this impulse shows itself in agitation among other men, although other causes may lead to the same activity. Sometimes the individual is constantly suggesting changes in other departments, is full of ideas. This may result from real creative imagination. But it may also reflect a general dissatisfaction, energies not finding disciplined channels for expression and seeking outlets through other channels likely to be equally fruitless in the long run.

All this is in addition to the direct and obvious loss from lack of training. That quality of product is proportional to skill, needs no demonstration. Even on jobs requiring little skill, on which the skill is all in the machine, the competent worker will get a better product, and his equipment will have a longer life.

APPRENTICE PATTERN MAKER at the U. S. Navy Yard, Philadelphia, stands by while his foreman and instructor checks up on his work

Lack of competence shows itself also in volume of output. We are beginning to learn from motion study how great is the difference between what might be called the "natural" way to do work—the way that the amateur figures out for himself—and the way studied out by the professional, who has at his finger tips the results accumulated in the past of all the good ideas, the discoveries, the happy inventions, and the knowledge of mistakes to avoid. Simply by the elimination of fumbling and unnecessary motions, it is being demonstrated time after time that the rate of output may be increased from 10 or 20 to hundreds of per cent.

Yet, when a worker learns an operation unaided, the work pattern arrived at by trial and error is almost certain to include fumbling, indirect, and laborious elements.

Time to Consider Training

All these factors indicate the very great possibilities and importance of organized training in industry. Yet most of us try to hire trained men rather than train them, or rely on the teaching that a busy foreman can do, guided only by the light of nature. When conditions become impossible, perhaps a man is imported to establish a training school in a belated effort to remedy the difficulty, forgetting that it takes time to work out training programs adjusted to individual needs and that the net effect of such last-minute efforts is likely to be merely an additional cluttering up of shop facilities and executives' attention at a time when neither can be spared.

It is no wonder that many such efforts were thrown out of the window at the time of the last labor shortage, as they probably will be in the next. For firms looking for increased business, the present is eminently the time to consider systematic training.

CHAPTER TWO

How a Man Learns

IN TEACHING a simple routine operation, the following is an effective order of steps:

1. The teacher explains briefly what he is going to do, what is the objective, what difficulties to watch for. The amount of material that can be imparted at this stage is limited by the attention that can be secured from the learner and should not be too great; many details are better explained in connection with the demonstration by the learner.

The object of this stage is to provide the learner with an understanding of the reason for the instruction, and with clues by which to get the significance of subsequent steps.

2. The instructor demonstrates the operation. He will continue his explanation of what to watch for and why he does the things he does, but will keep attention focused on the procedure. Again, the amount of material that can be imparted in one lesson or stage is limited. If the operation is complex, it is advisable if possible to break it up into elements sufficiently simple to be grasped by the learner. Thus learning to swim requires a fairly complicated coordination of motions

MANY FOREMEN at Ford Motor Company are training school graduates. Here a class is receiving instruction in the fundamentals of projection and mechanical drawing

of the hands, feet, and whole body, together with a timing of the breathing.

Each of these elements is in itself unfamiliar, and if all of them have to be observed by the learner from the beginning, many trials and much wasted effort may be expended before both the nature of the motions themselves and their relation and timing are grasped. If attention is successively focused on the character of the leg motions, arm motions, breathing, and so on, progress and comprehension will be faster. In the same way, in learning to handle a lathe, the beginner should be taught one step at a time.

A Matter of Imitation

The demonstration may need to be repeated several times before it is grasped by the learner. Questions as to points likely to be troublesome will direct attention to them and will indicate to the instructor the progress of the learner.

3. The pupil imitates the demonstration. In this connection may be mentioned the trial-and-error nature of learning. To the extent that the instructor is able to explain the details of procedure, imitation can be direct. But even in simple operations, such as handling a hammer, the act is accomplished by a combination of muscular activities which it is difficult if not impossible to reduce fully to words. The best the instructor can do is to describe the objective as clearly as he can, and leave the learner to experiment until he secures the result.

In swinging a sledge, power is secured by imparting momentum to the hammer; none of the actual work is done by the body. Power is a question of acceleration; the objective is to secure an unhampered swing of the arms, to finish the stroke with the grasp near the end of the handle in order to increase the speed of the head, and to relax near the end of the stroke in order to avoid fatigue. Accuracy of aim must be learned almost wholly by practice; about the only helpful advice is to become unconscious of the hammer, focusing the attention wholly on the target.

4. As the learner imitates the demonstration, the instructor turns his attention to the correction of faults as they develop. "Put more swing into the beginning of the stroke; you are lifting the sledge over your head instead of swinging it." And so on.

At this stage it may be necessary to repeat part of the demonstration. But the instructor should avoid doing the work for the student. To do so, deprives the learner of the practice which he needs, excites and embarrasses him, and causes him to lose confidence, and is apt definitely to lessen his interest in the proceedings, by depriving the task of the challenge of difficulty and the pleasure of mastery.

Not Everyone Can Teach

Many men who are skillful in performing an activity have little skill in teaching it to others. They may never have analyzed the process by which they secure the result. Particularly, they are likely not to have analyzed, or to have forgotten, the difficulties encountered by the learner. Being unable to help him where he needs help, and not understanding the process by which he must learn, their impulse is to push him aside and do the work themselves.

To the extent that the teacher can put his finger on the difficulty of the learner, and show him how to correct it, he will be effective in imparting skill. To the extent that he is able to guide the learner to his own discoveries rather than make them for him, he will be a stimulating and interesting teacher.

Regardless of his effectiveness in these directions, a third function of the instructor is to hold the student to the required level of workmanship, returning him again and again to the performance until it meets the standard. Learning will be faster with teachers proficient in the first two kinds of assistance, but if the student keeps at it, he will eventually learn from almost any teacher merely by being held to the required quality. He may, however, secure this quality by an indirect and clumsy method, hit upon by trial and error and hardened into habit.

If Held to the Task

At any stage of this learning process at which the learner becomes satisfied, the process stops or continues very slowly. On routine tasks, even a slow learner will eventually acquire high proficiency within the limits of speed and accuracy imposed by muscular and mental coordination, if he is held to the task and criticized long enough.

But when the man is satisfied, the principal incentive to improvement has disappeared. Many men thus acquire a more or less crude approximation to the desired skill, sufficient to get the result past inspection but far short in finish,

speed, and accuracy of what they could accomplish had they originally learned the task fully and correctly. The cost in time and materials and energies of the poor job is likely to be exactly the same as for a good job. The waste which results from half-way instruction is great and obvious.

One criticism of letting the man learn by absorption or by such incidental attention as the uninstructed foreman can give him is that, being left largely to his own guidance, he may become satisfied with his results and stop advancing almost anywhere on the scale from the point at which he just "gets by" up to the very highest quality of workmanship. Only a few reach the top, whereas many could nearly do so, were they systematically aided in the process.

5. The first time the worker "clicks" and achieves the correct performance, he is apt to experience a distinct thrill of pleasure, which causes him to remember the stages distinctly. It may happen, however, that the final combination is partly accidental and cannot at once be repeated. Furthermore, its details will soon be forgotten unless they are quickly repeated; the percentage of an idea or group of ideas remembered, increases with each repetition until the whole has been mastered.

It should be the purpose during the stage of trial and error to prevent mistakes from hardening into habit. Criticism and inspection should therefore be frequent. Once the performance has been mastered, it should be repeated until certainty has been attained and habits have been fixed, completing the learning process.

It Often Takes Only an Hour

Teaching of simple routine operations need require but a short time. With a man who knows his trade, has worked in the shop, and is familiar with its general background of procedures, the actual demonstration and practice stages should require, as a minimum and depending on complexity and number of elements, as little as an hour or even less. Follow-up and criticism of performance should continue for a few days, immediately and in detail as the man begins to use the new method in production, then at longer intervals until the lesson is mastered.

With beginners—that is, with people who have not worked in a shop, office, or store before—there are a good many things to be learned in addition to the actual operation. The new worker has to learn such procedures as recording time, the care of the machine or workplace, clerical routine, locations, names and faces, safety rules, and the like. One or two days of formal instruction, supplemented perhaps by an hour a day or later an hour a week for review, answering of questions, and elaboration of the original instructions should and does suffice in many cases.

Need to Remove Fear

In the process of learning by imitation, a number of difficulties may be met all at once.[1] To revert to the illustration of swinging the sledge, the worker must acquire accuracy, speed and power, and in this case he must learn not to be afraid of his tool. In teaching where there may be a fear of the tool, process, or result (as in starting a large machine, performing any heavy, noisy, or dangerous process, or any process in which the results of failure are likely to entail loss, discomfort, or danger), the first step is usually to remove such fear.

The telephone switchboard operator makes connections on a practice switchboard for some time before she is transferred to a board at which she must handle real calls from the general public. Even then, a supervisor divides her attention for a week or more among a small group of learners, ready at any moment to lend a hand should the operator become confused or should a momentary traffic peak be too much for her. Thus the operator is relieved of the panicky anxiety as to what she would do, were such crises to develop, and the more rapidly acquires confidence in her ability to meet them when they do arise.

TWO BOILER MAKERS in the making at the Philadelphia Navy Yard, where the local board of education cooperates to the extent of assigning a full-time instructor to the training of apprentices

The apprentice salesman practices his first sale in the presence of an instructor who takes only an incidental part in the interview unless a situation arises where a tactful word helps the beginner over a difficulty. The man learning to handle a sledge practices at driving a stake alone until he has attained sufficient skill and confidence to work, if need be, with another man, and has learned to take care of his tool so that he has confidence that the head of the sledge will not fly off.

Which should come first, speed or accuracy.

Gilbreth maintained that the first objective was to learn the motion as it was to be eventually performed, and pointed out that the sequence of motions used in a slow performance frequently differed materially from that used at normal speed. In principle this order is correct; assuming adequate instruction and supervision, the man should learn faster and have less to unlearn if he practices the correct motion sequence from the beginning and, having acquired it, devotes himself to the acquisition of skill and precision.

Slowly at First

Several factors may modify this conclusion in specific cases, however. Often the initial fear of a mishap is a serious difficulty, and the learner must take things slowly until he has learned and can forget, as a conscious distraction, the correct sequence and timing of operation elements.

How does the development of judgment and non-routine abilities, such as those of the executive or the technical specialist, differ from the learning of routine work habits just described?

In this type of training, as in the other, the first step is demonstra-

[1]See also *The Instructor, the Man, and the Job*, by Charles R. Allen, Lippincott, 1919, for an excellent analysis to which I am indebted for many helpful suggestions.

tion and explanation; the second is practice. But the thing demonstrated is no longer a single procedure or routine, but a general principle or classification applicable to many apparently dissimilar cases, which are nevertheless bound together and made partially or wholly soluble by the application that is common to them all.

Thus the toolmaker produces shapes of the greatest variety in metal, but he produces them by applying methods and expedients which he has learned, perhaps, in other situations, but which he recognizes as applicable in this. The foreman becomes a successful handler of men when he begins to recognize similar basic likenesses among the men in his charge. "Wosniak is behaving the way Martin acted. I wonder if he is having some sort of trouble at home." Or, "That fellow looks as if he needs glasses."

The modes of demonstration used for imparting routine skills are also available for developing these broader skills, although naturally the discussion and explanation of illustrative cases and problems replace physical demonstration. But the process is more massive and therefore takes more time. Many applications have to be made before proficiency is acquired. Many puzzling combinations and variations of the original theme will be met, and only slowly are skill and assurance built up. Consequently, the material is best supplied in smaller doses and over a longer period of time, affording the learner a longer period of contact with his instructor. Also the more physical bulk of the skills to be acquired is so much greater in the case of a toolmaker than in the case of a machine tender or routine assembler as to require a more extended period for its development.

Routine and Non-Routine Skills

As a result, one clear-cut difference between the development of routine and non-routine skills is in the rate of absorption possible. Where the vestibule training of the routine operator may take a day or a week, the apprentice course may take four years for the young man with grade or high-school education, or a year or more for the college man who has already had four years of systematic preparation in fundamentals and principles.

For such jobs, also, especially for supervisory and executive work, fitness depends not only on discipline of the mind, but on what might well be called the discipline of the emotions and habits. Willingness to assume responsibilities and dependability in carrying them out, the habit and assurance of command, and similar qualities must be formed by practice and learned sometimes by bitter lessons.

Then Comes Responsibility

For this type of development, thought-out plans of instruction are perhaps even more necessary than with the simpler teaching jobs, if comparable effectiveness is to be attained. But the actual method of instruction will be less explicit. A principle or a similarity will be pointed out, and the learner, his eyes once opened—to the existence of the relationship between fixed and proportional costs, for example—will, if he is a good man, go on developing the theme in his mind for years, gradually finding new applications and relating the one idea to others, thus building a philosophy of action. Or the learner will be given responsibilities, graded to the ability of the learner and becoming more difficult as mastery is increased.

The apprentice course is typical of this type of training. Training may profitably be carried far beyond this stage by the occasional guidance of individuals when in need of help, or by means of discussion groups of selected promising men, who are thus aided to increase their possibilities for effectiveness.

Because this type of training absorbs a much larger amount of time than is usually necessary with routine training, and is correspondingly more expensive, it is an advantage to spread it over a longer period of time, giving more opportunity for selection and winnowing.

In the selection of this type of man, it is often best to let him shift for himself to a greater extent than is advisable with a younger man. The point is to find the happy medium between lack of guidance which results in costly mistakes and may crystallize wrong methods, and a too great solicitude which fails to develop resourcefulness or to weed out those in whom it is lacking.

CHAPTER THREE

What Is to Be Taught?

PROGRESS in teaching will be faster if the instructor has set up definite specifications of the results he is trying to secure. For example, what trade terms, names of parts of machines or of tools, qualities of materials, will be unfamiliar to the learner? What should he know about the care of his machine, its possibilities and limitations? What computations, if any, will he be called upon to make and what background of instruction in arithmetic, blueprint reading, geometry, algebra, chemistry, and so on will he require in order to understand them?

Before attempting to teach a job, an analysis should be made of all the points on which instruction will be needed and of all the probable difficulties of the learner. This analysis may be formally recorded as in outlines to be used by more than one instructor, or if a new instructor himself is still learning how to teach or to analyze the job. It seems unnecessary, however, for an experienced instructor, who knows the operation well, to produce any great volume of paperwork in this direction, although it is just as important for him as for anyone to think out in advance and to catalog in the form of usable notes the things he is going to impart.

In addition to the technical aspects of instruction, there are a number of other fields in which it is necessary to train employees. The first transition from home or school to a job involves substantial adjustments of habits and attitudes.

Adjustment Is Not Easy

For example, the college graduate has for four years or more performed in an environment where the whole effort was directed to his progress and development. He finds himself suddenly transported to a situation where he is held to routine tasks which appear to contribute little to his advancement, and works for people who appear to be interested in him only for what they can get out of him. The adjustment is a severe one in many cases; it may be expedited under the general guidance of men who understand

his problem, having been through it themselves, and who in either periodical or occasional interviews help him to orient himself to the new situation.

Any new employee has a number of details to learn, detailed procedures and customs of the shop as to hours, manner of payment, collective bargaining arrangements if existing, eligibility to insurance and other benefits, social organizations, classes, and other activities, even such small details as the correct clothing to wear where there are occupational requirements, the rules as to absences or tardiness, etc.

Introducing People to Their Work

Usually the employee picks up most of these without assistance. But many firms gather up such information of a general nature and supply it to the employee at the time he is hired, in a compact book of instructions, suggestions, and rules. Foremen should be instructed and checked up from time to time, to see that in introducing new people to their work they are covering the instructions, introductions, and other details not otherwise taken care of.

Even with employees experienced in previous jobs, there are frequently problems of emotional adjustment to be made. Frequently, difficulties of adjustment trace back to more or less ineradicable earlier emotional experiences or crises. The boy coming from an underprivileged home may react in various compensatory ways, some of them in the direction of excelling by achievement, others in directions less desirable, as ostentation or attempts to dominate or bully.

Often the individual will reflect the lack of a sufficiently firm or informed home discipline, or the existence of discord between parents, or the shrinking from responsibilities which may result from parental over-solicitude and coddling.

In general, we are probably interested in such cases in order to avoid assuming the responsibility for other peoples' mistakes. However, personnel workers or foremen whose attention has been directed to the question of emotional adjustments, as by discussion and analysis of typical cases, can sometimes give real help to employees who are meeting some crisis at home, in their business matters, their work, or their relations to their fellow-employees. Such training of foremen may also do much to eliminate the mistakes so often made by untrained men in handling people.

A CENTURY OF EXPERIENCE in training mechanics stands back of the apprenticeship system at Brown & Sharpe Manufacturing Company, Providence. These apprentices get regular shop rates for classroom work

It has been the experience of several employers that a real problem is met in re-employing men who have been idle for some time during the depression. Such men, resuming their old jobs, find themselves slow and clumsy; it takes time to reacquire the old habits and speed. At the same time these men feel that everything depends on being able to demonstrate that they are as good as they ever were. Consequently, they are apt to force themselves and their work, which results in a trembling exhaustion for themselves and frequently in excessive spoilage of materials or tools.

Told Him to Go Slow

In one case a recently re-employed man, formerly known for his dependability, broke an expensive tool, and instead of reporting the loss, attempted to cover it up. The emergency was too much for him. This happened a second time. Very wisely the employment manager, instead of precipitating a real crisis by threatening discharge, simply called the man in and told him that he was severely at fault for not reporting the accidents and would be discharged if he failed to do so in the future, but the company expected it would take a little time for him to get on his feet again, and would prefer to have him go slower and run less risk of breaking tools or hurting himself until he had had a chance to build up his speed again.

Assuming that an analysis has been made of the adjustments, instruction, and training necessary to prepare a man for competent performance of a job, the next step is to find what elements of this training the candidate already possesses. Here systematic personnel procedure is helpful. The employment department should have records that will show the education and experience of the candidates for training. Other valuable information may be yielded by such tests as those for trade skill, for intelligence, dexterity, quickness of reaction time, memory, ability to hold the attention, and other qualities.

The use of systematic tests in hiring presents some difficulties for the smaller plant; the method is not yet sufficiently standardized to be used with much benefit except by persons trained in psychological technique. Of course the tests are not always conclusive, but the correlation is high when they are properly applied.

Pressure a Mistake

Whatever the method of examination, employees should not be admitted to training courses, except of the general and inspirational type, until they have been investigated for specific preparation and deficiencies, as well as for general promise of ability and intention to profit by the course. This may be determined by interview, on the recommendation of foremen or other superiors, by announcing that the courses will be offered, and inviting registration (subject to approval or examination), or by similar means.

Generally it is a mistake to put much pressure on a man to enroll unless the training is one automatically given to all persons on that particular job. The high-pressure methods sometimes used to induce men to attend evening classes or lecture courses are often most unfortunate. Men are induced to attend who have no real interest in learning or advancement, but who feel that they will be unfavorably noticed if they do not participate. Their presence is a continuous drag on the class and the instructor. Usually the class that is thus hastily organized is inadequately planned in other directions; after the first few lectures are over and the boss stops coming, attendance shrinks, a pall of futility settles over the group.

CHAPTER FOUR

What Type of Instruction?

WE MAY first distinguish several typical purposes of instruction. These may be:

1. To teach beginners a new operation or skill.

2. To improve the performance of men who are presumed to know their work but are found to be a bit below par.

3. To prepare employees for changed occupations or procedures, or for promotion. Thus training courses for foremen, for operators of a new machine, or for new inspectors.

4. To increase employees' interest in the work.

5. To keep supervisors, staff men, specialists, and others whose work involves knowledge as well as routine skill abreast of the best practice in their fields.

6. To direct interest and attention to special fields, such as safety, citizenship, motion study, health, and the like.

7. To provide a new interest and activity for people whose work is routine. Thus dressmaking, homemaking, or hobby courses.

8. To develop an all-round knowledge of the business in men selected as promising executive timber. Many of the special apprenticeship courses for college graduates have this purpose.

Typical Training Methods

The method of training will vary with the purpose and the group to be taught. The following are some of the typical methods, employed alone or in combination:

1. *Lectures or talks.* They may be given by fellow-employees who are specialists in the fields covered, or by similar men from near-by plants. Or experienced speakers may be secured, professional lecturers, teachers, and the like.

The purpose of the lecture may be either inspirational or definitely instructional. Inspirational lectures have their place from time to time when they are effectively given, ring true, and fit the situation at the plant. A good lecturer can reawaken belief in the possibility of achievement and the worth-while-ness of effort. He can, to a man shut in by prosaic routines within four narrow walls, bring something of drama and of glamour. He can cause men to see old problems in a new light, to renew their interest in what is going on outside the factory walls.

Such talks, cannot, however, be achieved merely by intention. Know your speaker before inviting him.

Disadvantages

Instruction is also possible by way of lectures or formal talks, except with men already deeply interested and well advanced in their fields. The lecture requires no active effort on the part of the listener; the speaker has little indication of the extent to which his audience is with him.

2. *Instruction classes.* Here lessons are assigned, either in standard texts or in manuals prepared for the purpose. Recitation may either be drill work covering the material in the text, or discussion of problems requiring for their solution an application of the methods or principles outlined there. The latter is generally the more effective, as the participation is less passive, the interest is greater, and the difficulties of the learner become more clearly apparent.

3. *A variation of the two preceding plans is to call on the members of the class to present papers or discussions in turn.* Thus the finishing department or the stores or tool departments may describe their operations, and in particular tell how the work done by other departments affects the results they can secure, and the ways in which they are attempting to contribute to the effectiveness of the others.

The preparation of such papers may have a high teaching value for the one who prepares them, compelling him to scrutinize and justify many things perhaps formerly taken for granted. With an opportunity for well-directed discussion, such meetings may be made interesting to the more passive participants, who meanwhile are interested because they are unconsciously comparing the speaker's performance with their own, past or prospective. The discussion may also bring up inter-departmental problems for mutual examination.

Without effective chairmanship there is a danger that such meetings may arouse antagonisms. They cannot be recommended very highly as methods of instruction, except for what the speakers learn in turn from the experience. The participants usually know little about effective teaching presentation. Such meetings have a definite place, however, as a means for introducing the discussion of inter-departmental problems.

4. *Learning by performance.* For teaching routine operations, this is the most effective method. All lectures, explanations, and readings are directed to the single end of enabling the learner to apply them to cases; the more directly this application can be coupled with this instruction, the more rapid will the progress be and the greater the interest.

The general stages in this method of teaching have already been described. Usually several presentations will be combined. In the apprentice course, for instance, classes, demonstrations, performance, and other methods are all used. Several methods of presentation may be employed.

Methods of Presentation

First, as to the directness of application:

(a) The learner may work on demonstration or practice material, or else

(b) He may learn directly on production jobs.

Whether to use the first or the second method depends on the following considerations:

(a) There is a greater stimulus and sense of reality in producing things for use than if the product is to be thrown away.

(b) If the product of the learners' efforts is usable, the cost of training is materially less. Often it is possible to start the learner on the rougher operations or lower grades of work, on which he may acquire the skill required for higher grades of product.

(c) On the other hand, the product of the learners' efforts may not be usable. In that event it may be possible to practice on cheaper

grades of materials, rejects, short ends, and the like. Generally, production of a usable grade of material is to be preferred if practicable.

Second, as to place: Should the teaching be done in the shop or in a specially equipped school or training room? In favor of the use of a separate room is the freedom from distraction of the learner. Especially with the new worker, the work will be learned faster if the student is not at the same time distracted by unfamiliar surroundings. Use of the separate room also facilitates the work of the instructor, who has his pupils under his eye instead of scattered through the shop, and whose demonstration and practice equipment is not subject to production calls and interruptions. It may be noted, in passing, that production work may be done in the schoolroom, if otherwise feasible.

Expense a Consideration

On the other hand, the equipping of a schoolroom, particularly if really up-to-date machinery is to be used, may entail more expense than is warranted. After all, if the learners are not already used to shop conditions, they must eventually accustom themselves to them.

A workable compromise may be secured by having available a classroom in which demonstrations, explanations, and discussions can be carried on, and perhaps the beginning operations taught if learning them requires little equipment. This room may be one used for other purposes — conferences and foreman's meetings, for example— provided the combined schedule is not too heavy. The learners will be transferred from the classroom to the shop fairly early and will continue learning there under direction.

This arrangement requires correct authority relations between the instuctor and the foreman, if such irritations as disputes and conflicts of authority are to be avoided. Putting apprentices or learners into the physical bounds of a foreman's department without putting them under his authority, invites trouble. The better arrangement would be to assign the learners to the foreman under whom they are eventually to work, making them responsible to him for discipline and obedience to any orders he may give.

The work schedule of the learner will be laid out by the instructor after conference with the foreman to see that there is a reasonable accommodation of schedule to rush orders and other production difficulties. The instructor will work closely with the foreman, discussing with him the needs and progress of individual learners, and the foreman himself will give the learners what assistance he can, being careful, however, to back up the authority of the instructor.

Individual Instruction

Instruction in this case will necessarily be mostly of individual type, the group being adjourned to the classroom when it is necessary to give a demonstration or group discussion.

A third choice of alternatives in training by doing is as to instructor and instructional organization. Shall the teaching function be assigned to foremen, to whom it is traditionally delegated in the average shop, if considered at all, or shall teaching be made a full-time job? Here again there is no universal answer. The small shop will not support a full-time instructor and will perforce secure what results are possible through its regular foremen and executives.

It may be that the duties to be learned are simple, requiring only a short period of supervision which the foreman can take care of in his stride. No better human relationship is conceivable in the shop than that between a competent workman and a foreman whom he respects and to whom he feels he owes his trade skill.

The work of training fluctuates greatly in volume. There should always be some training activity going on. When new men are not being put on, up-grading, supervisory, and general teaching programs should be under way. If the volume of this work is sufficient to give continuous employment to one competent man, or can be combined with related personnel duties to keep a good man busy, it will usually be advisable to provide such specialized direction. But in many shops even this much is not practicable.

Foremen as Teachers

Ability to teach is not inborn in foremen, although they are usually selected because of aptitudes in that direction, among other qualities. If foremen are also to be teachers, they must be taught to teach. When this has been done, and with a continuing but not too obtrusive follow-up, very fair results may be had. The teaching function and attitude, incidentally, will improve the quality of the supervision in other directions, provided it does not unduly burden the foreman.

In a shop where duties were specifically planned to allow the foreman time for the necessary work of instruction, and in which he was carefully instructed in methods of

OVERHAULING a universal grinder is part of the Ford course in machine repair

APPRENTICE ELECTRICIAN learns how to wind an armature at the Philadelphia Navy Yard

teaching and systematically followed up, a better average grade of instruction would undoubtedly be secured than in one where, in order to meet sudden labor demands, instructors were imported who were untested and were not acquainted with the shop, its problems, or its personnel.

On the other hand, it is difficult to arrange the duties of the foreman so that he has time to do a systematic job of training. At the very time when this problem reaches its peak, his regular responsibilities are growing by leaps and bounds. Furthermore he is called on to divide his attention between two not wholly compatible responsibilities—getting out production and teaching. The latter is hard to reconcile with the former, because output must be subordinate to learning, and there must be a genuine and sustained interest in and supervision of the progress of each learner in order that his individual difficulties may be understood and corrected.

Too Heavy a Load

From all these standpoints, particularly from the standpoint of getting out the production when it is needed, it appears that the foreman should not be burdened with the primary responsibility for training new people. During slack times or periods it would be a smart move to encourage him to do up-grading or re-training work among his regular employees, provided he is adequately equipped for this work.

If we do not look to the foreman, to what source can we turn for instructors? Teachers or ex-teachers in manual training schools, or other teachers who know or can learn a trade, offer a very limited but good source of men. College graduates who have majored in education, psychology, or in the right kind of personnel courses, and who have had or can be given machine or trade experience, should be equipped to instruct, if otherwise qualified. But the limited numbers of such specially trained men available in most places make them more suitable for consideration as supervisors of training programs than as instructors.

The army is an organization in which rapid extension to meet sudden peak loads is a central and vital issue. The need is met by maintaining during peace times a nucleus of trained men, of whom a large proportion can rapidly be turned into reasonably competent instructors on occasion. If the need for expansion is very great, as it was during the last war, the first step in the expansion is to train instructors to train the incoming hordes of recruits.

Army Methods

This training is a functionalized, group job. The prospective officer goes to classes in which the specialist's competence is diffused with a maximum of rapidity. He learns to care for and operate machine guns in squads, supervised by machine-gun specialists. He studies military law under the adjutant. Meanwhile, in squads small enough for personal supervision, attention, and advice, he is being taught the rudiments of discipline, living under combat conditions, and of hygiene, and is being built up and conditioned by unremitting drill. Naturally, in so large a mass undertaking, not every instructor is competent, or secures the best results in the handling of men. But as a mass undertaking it produces results.

Industry also learned something of the same technique during the same national emergency. The technique is available for future needs.

Such a program of expansion should be headed up, if possible, by a man experienced in and professionally equipped for teaching. If such a man is not available in the organization, it would be good insurance for any company looking for substantial expansion in the next two years to look about to find one, or to begin developing one in the very near future.

It may be laid down as a generalization that any training program should by all means be headed up by such a man. The work of training must be paid for somewhere. If this work is not done systematically, it will be paid for just the same in interruption of the work of foremen and in their less competent, because uninstructed, performance up to the time when competence is finally attained. If this time never comes, the cost will be paid for, and probably many times, in the slowing down of production and capital turnover, in lowered quality, increased spoilage, and in added expense and trouble of supervision.

Trained Teachers Cheaper

Just as we have found that it is cheaper to have clerks do clerical work than foremen, and to have purchasing agents do buying rather than superintendents, so it is axiomatic that, where the problem of training is other than rudimentary, it will in the end prove cheaper to make the function of instruction the sole or principal responsibility of a trained man. He will, if he is competent, develop a workable utilization of the material available. If it seems best to use foremen as teachers, they will be taught how to do the job, and will be supervised and guided in doing it.

A knowledge of motion study will be valuable to the instructor and training supervisor. Indeed, an experienced time-and-motion study man would be one of the most promising candidates for training supervisor, if otherwise suited. We have not yet generally developed the possibilities of the motion-study technique as a method of analyzing operations and making records of them that can be transmitted and taught to other people. As this technique is further developed, it is possible that the primary approach to the rapid imparting of routine skills—and the ability so to impart skill is the very kernel of the problem of rapid expansion of force—may lie through motion study. Knowledge of motion study, however, must be supplemented by a knowledge of how to teach.

Turning to the question of where

the supervisor can find material from which to develop instructors, one of the best sources may be made a byproduct of developing understudies for foremen. Assume that a course is given, if possible, before the rush of new work is actually upon the organization, in which men who desire and who pass a preliminary selection are enrolled in a training course for foremen. The Western Electric Company operated such a course, for training inspectors, about 1930.

Chance to Advance

Preparation for the work of inspection, or indeed for some other similar advancement, might well be made the ostensible theme for the course. It is made clear from the beginning that the company does not expect to be able to promote or advance the wages of any man who takes the course. It is simply a facility for self-advancement placed at the disposal of men who are interested in learning and preparing themselves for the future.

The course is carried through to the finish, with careful attention not only to appropriate technical subjects, but also to instruction and actual drill in the organizing and presentation of teaching subject matter. Records are kept of the performance, and impressions made on the instructor, by each man who finishes the course, and he is given a suitable certificate, signed by the instructor, the factory manager, or possibly the president.

From the graduates of such a class, after scrutiny of characteristics and employment histories, a fair proportion may be selected with confidence as prospective teachers, and given further specialized instruction, which can be shortened because a background has already been provided.

Success as an instructor, from the standpoint both of obtaining results and of being able to adjust oneself to the practical production necessities of the department, is a good indicator of promise as a foreman, so that this chain of teaching may, if necessary, be made to provide in part for expansion of the supervisory force as well.

When Time to Demobilize

Promising material for other positions—staff and supervision of clerical work—may also be uncovered so that the task of demobilizing the instruction staff, once the peak need has passed, presents no more difficulty than does any case of stabilizing or contracting a suddenly increased force. As the training emergency passes, the instructors will gradually be absorbed into the staff and supervisory force or returned to the ranks, leaving only the supervisor and possibly one or two assistants in the large organization to carry on the long-time program of upgrading, training of apprentices, and similar projects.

A word may be added as to the qualifications of the instructor, aside from a knowledge of and experience in instruction. Obviously he must know the trade or operation to be taught. A supervisor may not know every operation to be taught, but he should know what constitutes competence in a trade, and should be able to assist men who do know specialized trades to organize their knowledge and present it effectively. The instructor should have to a reasonable degree the gift of facility and clarity of expression. Some men who are adept at performance are virtually inarticulate when they come to describe it.

The instructor should have an analytical mind; he should have formed the habit of classification and of looking for the underlying reasons and causes for results.

He should be patient with his pupils and free from any inclination in any way to enjoy or indulge himself at their expense. He should have a quick enough mind so that he will usually be able to keep one jump ahead of his class.

The instructor should also be a good disciplinarian, not only patient but also firm. He should be able to distinguish between the genuinely troubled and stumbling learner and the inattentive or lazy one. He should not condone or overlook low standards of workmanship or infractions of discipline arising from carelessness or indifference rather than from ignorance.

Age a Minor Factor

As to age, there seems to be no special limitation. Very young men may fail to carry conviction or to have sufficient patience or experience with men to do a good job. Older men, on the other hand, may have become fixed in their habits and have stopped growing. Except for this possibility of settling into a rut, age seems to be a distinctly minor factor in a man's ability to learn, or, conversely, to teach.

Assuming that the instructor has been selected and trained, his first handling of a class should be supervised. The new instructor will teach the class, the supervisor taking his seat unostentatiously with the learn-

COSTS ABOUT $40 per boy to train apprentices at the Norton Company, Worcester, where an 18-month training course was successfully revived a year ago and is now in full swing

ers, ready if necessary to take a hand in directing the discussion, although carefully avoiding any reflection on the qualifications of the new man. Any faults observed may be made the occasion of subsequent comment and suggestions in private.

A fourth point at which a choice of methods is called for in organizing a training course is as to the number of men the instructor should handle at one time. Learners may receive individual instruction. They may work in small groups which are handled partly by individual attention to the needs of each man and partly by demonstrations and explanations given to the group collectively. Or the demonstration or lecture may be given to large groups, perhaps so large that individual attention is impracticable except in separate groups or subsequent contacts.

How Big a Class?

A first consideration in deciding this question of size of class is the uniformity of the preparation of the learners. When all members of the group are beginners, six or more men may each profit as much by a demonstration as one would, if the group is small enough so that the men can see it well. Indeed, granted that all members of the group can get a good view of what is going on, there is virtually no limitation to the size of the group so far as perception is concerned.

Moving pictures are proving an effective means of supplementing direct demonstration. By a proper use of telephoto lenses, slow motion, lighting, and filters, we can make clear to a large audience things that it would be most difficult for any one of them to observe unaided.

For example, a close-up in slow motion and then at normal speed may show exactly how the skilled operator handles her tools in a fast assembly job, or just exactly why one method is faster or better than another. The apprentice welder may see, by means of pictures taken through infra-red filters, just what happens in making an arc weld. He sees the drop of metal form and flow from the end of the rod. He sees how and under what conditions bubbles form. Motion pictures are an exceptionally effective teaching tool for process instruction, safety instruction, health and general propaganda, and other teaching purposes including technical observation.

Where there is any substantial variation in the preparation of learners, group instruction has its limitations. One man will have covered part of the lesson that must be given the others; until the group catches up, his time is wasted and his interest lost. Unless it is possible to start newly hired learners at short intervals in classes—a plan probably worth while only when large numbers are to be handled—the instruction of newly hired learners will be largely individual.

Lack of Contact

A second limitation of the group method is the lack of contact of the instructor with the individual needs of the student, a lack which becomes more apparent as the size of the group increases, until finally all individual contact is lost.

This lack may be offset to some extent by the increased stimulus that comes from well-directed group instruction. The members of the group teach one another; the contribution of one man brings to the surface the ideas of another. There is also some competitive stimulus in such participation in a group discussion, which puts some men on their toes, although it causes others, unfortunately, to withdraw into their shells. The value of this stimulus depends to some extent on the number participating. With too small a group, say five or six, it may not be appreciable unless and until the members become well acquainted, about equally matched, much interested in the subject, and well led.

Up to perhaps twenty men the competitive stimulus tends to increase. Above this point, and with some groups and types of discussion before this number is reached, it becomes impracticable for all to participate freely. The instructor has to assume more and more of the initiative in the discussion, while that of the learners becomes less and less. Finally the lecture stage is reached, a method of instruction which, as noted, is suited for certain purposes such as general stimulus or explanation, but which is unsuitable for finding and removing individual difficulties in learning.

This brings us to a fifth detail in the planning of shop training—the question of time. How long should a teaching session be? The proper interval will of course vary with the type of instruction and pupils, but it should not be forgotten that learning is hard work, and makes much greater demands than does the performance of a task that is so familiar that the operator can nearly do it in his sleep. Actual physical fatigue may be an element where the operator is using unaccustomed muscles and is endeavoring to make up by brute strength what he lacks in skill.

APPRENTICESHIP, according to a Brown & Sharpe official, instills a spirit of loyalty and implants stability in young men who might otherwise shift about in search of the never-to-be-found ideal job

Group Discussion Fatiguing

In most cases the element of physical fatigue is secondary to the exhaustion and sense of bafflement that comes from the initial trial-and-error attempts at performance, unsuccessful or at least unsatisfying. First lessons may well be short, the time increasing as the operator acquires proficiency, assurance, and interest.

Group discussion is also fatiguing. With the beginner there is apt to be a definite tension, a fear of being unable to answer, or of ridicule from the instructor or other members of the group. The instructor should constantly endeavor to put the individual at his ease; sarcasm is not a good tool to be found in the teacher's kit. Aside from this ten-

sion and the fatigue of newness, there is both stimulus and a high rate of fatigue in participation in an active group discussion.

One writer has said that, while the public speaker or leader may use up very little muscular energy, the demands on attention and on the emotions involved in such activities, release stimuli which cause the tissues to burn with a bright, clear flame. All participants are subject to somewhat similar reactions; even if a man gives up trying to get a foot into the door of discussion, he is apt to find his head hot and his feet cold; he is under all the tensions afflicting the participants with the added one of feeling that he should take part but is not equal to doing so.

How Big the Doses?

For these reasons, discussions should ordinarily be limited to an hour or an hour and a half. Discretion must be exercised. Small advanced groups may want to absorb big doses; beginners and those accustomed to group discussion will react better to considerably shorter periods. Formal lectures should seldom go more than 40 minutes without some sort of break in the form of discussion, entertainment, or other interruption. In long sessions it is a good thing to recess briefly or at least invite the audience to a "seventh inning" chance to stand up and stretch.

Should instruction be given on the company's time, or the employees'? The answer to this is that in general all such work should be on company time. One exception to this rule is that hobby classes, or classes as in accounting which are merely provided as facilities open to ambitious learners without any sort of pressure to enroll, may properly be offered as evening work, taking the place of classes which the same employee would probably attend anyway, and at his own expense. Another exception may be made in meetings occurring probably not oftener than once a month, at which talks or other interesting and not too heavy forms of instruction are combined with a dinner and perhaps some entertainment feature.

At what time of the day should instruction be given? For beginners who are taking a formal training course, usually the best time for absorption is in the morning before the worker is tired (and the first couple of weeks are tiring weeks for the average beginner).

Where individual instruction predominates, the group may be brought together late in the afternoon, and while the details are fresh in mind, to answer questions, summarize the day's advances, and prepare them for the next day's practice. It is always helpful in presenting a new idea to give it time to soak into the learner's mind overnight.

Classwork in Shifts

With an active program and many learners, classwork may be done in shifts, one shift working on the floor under supervision of foremen or instructor, while a second group is receiving class instruction; one group being on the floor mornings, the other, afternoons. One company, which runs an extensive school, alternates the students from shop to school at intervals of two weeks.

CHAPTER FIVE

Teaching Procedures

THE STEPS in learning named in Chapter Two were explanation, demonstration, imitation, correction or adaptation, and fixation.

In order that the learner may make reasonable progress and be encouraged to further advancement, the task should be divided into elements, the first of which is within the present grasp of the learner and furnishes him a foundation on which to progress to the next step. Allen calls these elements "blocks," and suggests that in planning the instruction it be divided up into such blocks or lessons. The amount of material to be included in a block will depend on the time available for the lesson and the absorbing capacity of the student. Thus, a first lesson for prospective stock-record clerks might cover the general reason for and theory behind stock control, the explanation of a typical stock record form, and practice in making simple entries.

The second lesson might present the routine by which the stock clerk's requisition originates a manufacturing or purchase order, and of how the material is recorded on receipt. This lesson might conclude with a trip through the plant, pointing out and explaining the actual steps as they were encountered in actual operation.

The third lesson might take up errors, how they originate, how they may be found and avoided, or corrected if found, and what is required in the way of follow-up or report in case an error is located. This lecture would contain an allusion to the detection of frauds and might conclude with practice entries and an example, to be worked out by the student after discussion, illustrating the probable cost of an error.

A fourth lesson might take up the question of stock limits, explaining the importance of this method of production control, the responsibility of the stock clerk, and his discretion and limits in ordering.

Supplementary Instruction

All lessons after the first could be given daily for the first few days until essentials were covered, then weekly, while the student is actively at work posting, an hour being taken off from work each time for the lesson. Such instruction should of course be supplemented by guidance and inspection on the job by the chief inspector, the stock clerk, or another qualified person.

Should explanation, instruction in principles, and theory precede, accompany, or follow actual demonstration or practice? This question will arise in laying out the blocks. In general, at least a brief explanation should precede the demonstration; the learner will not otherwise understand what is happening or be able to focus his attention on any one feature with sufficient intensity to remember it.

Where the demonstration of a lesson requires more than one period of observation, the best plan will be to repeat the demonstration, directing attention first to those elements of performance that must be understood and mastered before the next can be performed. Performance by the learner follows, attention being directed to acquiring proficiency in the element under observation. It is not always possible to separate out elements for such performance; performance may not be possible until all have been mastered. Thus a man cannot safely drive a car until he can simultaneously control the steering wheel, the gear shift, the accelerator, and the brakes.

TWENTY-SIX ENGINEERS from eight states and two foreign countries attended the December, 1935, session of the special welding engineering course offered each month jointly by John Huntington Polytechnic Institute and The Lincoln Electric Company, Cleveland

Often, however, it is possible to set up practice models that stimulate one element of the performance with sufficient accuracy to give practice, so that when the combination is tried the learner has mastered part or all of the elements and can concentrate on their successful synchronization.

From Known to Unknown

The first time a course is given, it is advisable to write out in detail the steps and questions by which the learner is to be led to a perception of the point to be presented. The first step should be to establish familiar ground of experience from which to proceed to the unknown and tie it up with the known. Thus the stockkeeper-to-be may approach the notion of debits and credits through the idea of a custodian who gives a receipt, or from some similar familiar angle. The instructor in laying out this approach will work back from the objective or difficulty to find the common ground from which it may be approached.

Should the approach in teaching be to present one phase of the subject at a time, as, for example, to cover the complete clerical procedure in stock-record work before approaching the explanation of the place of these records in the general plan of operations, or to reverse the order and outline the relation of the department to the general procedure before going into detail?

Here again it is unsafe to lay down a flat rule. A fairly considerable foundation of theory or explanation may be necessary before the succeeding stages become comprehensible. Generally a better and more natural order is to carry the various parallel lines of development along together, so that the learner grasps first all the elements in a simple situation and is able to master it, then proceeds to more involved performances calling for the addition of new elements to those already learned.

Thus the laying out of a hole for drilling without the aid of a jig may be made a natural occasion for a lesson in simple geometry. It may be noticed that in the brief illustration of stock-record work the order of presentation was built up in this way. Trade terms, for example, are more intelligible and more easily remembered if they are introduced with sufficient emphasis and explanation at a time when they are required by the performance.

The general stages in teaching may be analyzed into the following four—preparation, presentation, application, inspection. Of these, the first corresponds to the stage of building from the familiar to the unknown. If this stage is developed too fast, the learner does not follow or completely grasp it, and may not get the next step. If the rate is too slow, the student's mind gets ahead of the presentation and his attention is lost. The class should be watched, and the pace adapted to its needs.

Gradual Elaboration

The stages of presentation and application cover the explanation of the principle and its application or demonstration in specific illustrative cases, the application giving an opportunity for elaborating the presentation at a rate sufficiently gradual so that it may be absorbed by the learner. The stage of inspection serves to indicate to the instructor that the connection has been made between the learner and the idea, as well as to give the learner an opportunity to make the application himself. This test application may be in the form of a problem or case submitted for analysis, or of a straight question testing the student's grasp, or the performance of the operation under discussion.

Interest is an important factor in learning; the length of time for which an impression will be remembered, and the sharpness with which the details will be retained, are closely related to the intensity of the original impression.

There are various means by which interest may be increased. With groups unaccustomed to sustained thinking, the span of attention that can be given to one idea, especially one at all abstract, is comparatively short. Here it is necessary to present the thought in very short steps and at frequent intervals to interrupt the chain of argument by an anecdote, an illustration, a pause for questions, or some other change of tempo that captures the involuntary attention of the listener and does not permit it to wander. Change of inflection or of rate of delivery also add variety and make it easier for such audiences to attend; these expedients are usually helpful with any audience.

The most complete attention will be had when a demonstration or explanation in which the learner is interested, proceeds logically, building up from one stage to the next and carrying conviction as it de-

velops, and when this development is carried on at exactly the right pace for the listener, so that he neither gets ahead of the speaker's presentation nor falls behind.

Because the tempo of different minds is different, it is impracticable for a speaker to adjust his tempo or rate of delivery to that of every man. He can only hit an average, relying to the extent that may be necessary on extraneous expedients to bring all the listeners into step from time to time. Jokes and similar interruptions to the current of thought, unless they serve at the same time to develop it, are a concession to the weakness of the audience or an admission of the weakness of the speaker, where the purpose is serious presentation and demonstration. They should not be over-emphasized.

Sensing the Right Pace

There is a certain mechanics to the grasping of an idea. In proportion as the idea is novel or complex, it must be turned over in the mind, played within a sense, repeated in new aspects and connections before it is assimilated. The art of the good speaker or teacher lies partly in sensing the pace of his audience, realizing when the point has registered and until then developing and re-illustrating the idea to give opportunity for its absorption. This pace will vary with the mental habits of the audience.

One effective speaker to shop men has developed a deliberate manner of speaking. He enunciates his words slowly and distinctly, and frequently paraphrases the idea two or three times before going on to the next. The pace would be wrong for a group of executives, but is just about right for groups which, whatever the native intelligence of their individual members (and this intelligence is not to be underrated), are not as a group accustomed to listening to speakers and do little purposeful reading or studying.

Because of this inertia factor in absorption, too many ideas, even simple ones, should not be presented in one lesson. The most successful lesson is usually one in which one major idea, such as the question of quality or of the responsibility of the worker, say for accuracy in carrying out instructions, is made the theme of the entire lesson, with related ideas such as the effects of poor quality on assembly, or on cost, or in the service given the customer being brought in and tied to the central idea, explanations being supplied as to how quality may be obtained in specific cases, but the discussion never straying far from the central idea.

If a miscellany of instructions, presenting no difficulty to the understanding and requiring merely remembering, is to be presented, it may be accomplished by giving the employee an instruction book or sheet to read, perhaps checking the list afterward to test his grasp of the items.

It is often a good thing to review the previous lesson briefly before starting on the new one. Limits of time will govern here, but the review provides the necessary familiar ground from which to proceed to the new idea, and also helps the student to orient himself and recall the thread of the discussion.

Certain factors in intrinsic interest may be considered. A first rule, already mentioned, is that it is usually inadvisable to over-persuade students to enroll in the course. Those who enroll voluntarily usually have a strong career interest which the instructor can tie into the lessons by showing the student how he will be able to utilize the lesson after it is learned.

Personality Counts

The personality of the instructor is quite a factor in interest and class attitude. He must be friendly, without signs of over-eagerness. It is important that he be sufficiently well informed to avoid bad breaks that destroy the confidence of the class in him. On the other hand, knowledge of the subject and ability to impart it are more important than personality. Many men of good personality are not very good teachers, and rely on their personal charm and leadership to hold the interest of the student. This may be done without a very effective job of teaching having been accomplished.

There seem to be three typical stages in the teaching of any given class. The newcomers are not adjusted to the method of the class, are timid or skeptical and tend to lag behind the pace of the instructor. If the teaching is successful, this attitude gradually merges into one of increasing interest and confidence, and the class begins to push the instructor. If this reaction fails to develop, the method of presentation should be examined to see whether the pace is wrong, whether vital factors in the demonstration have been omitted, or whether there is not some similar failure to adjust the teaching to the student's needs.

A factor in interest which must not be forgotten is that the course should be connected as directly as possible with the opportunity to apply its lessons to personal advancement. It is better not to train future foremen, for example, for whom there is no possible present outlet, although enough should be included in a class to allow for selection from those who make good records. One simple and significant factor in interest is the ability of the instructor to get the learner to do the work, merely clearing the path for him and providing him with tools. The less skilled instructor does all the work himself.

Industry's Job

At best it is usually difficult to secure or train really competent instructors in sufficient numbers for the average business. In the smaller businesses, the responsibility usually has to be delegated to relatively inexperienced men who have other duties as well. It may usually be taken for granted that, when organized instruction is available in the community, the organization is wasting its time and is likely to be doing an inferior job by duplicating the process.

On the other hand, the adjustment of the individual to the conditions and skills peculiar to a single company is not properly the business of public agencies of instruction because, for one reason, of the rapidity of technical instruction even in the basic crafts and trades in public schools, and to a very large extent this function is left to industry. Before any systematic training plan is started it is a good plan to make an informal and not necessarily elaborate survey of what is being done in the community, and to articulate the plant plan with the general community program so far as possible.

Continuation school programs, for example, should be carefully considered and availed of to the extent that they are useful. In most large towns, evening courses are offered in English, arithmetic, drawing, accounting, engineering, higher mathematics, and a great variety of other useful subjects. In some universities, research work is being carried on or research facilities are available that may with mutual

profit be applied to the problems to be solved or investigations made.

Mention must also be made of the excellent work done in some cities, as in Milwaukee and Philadelphia, in the training courses offered by groups of employers, or by trade associations and similar employers' associations. Foremen's clubs are a common cooperative community enterprise which offer substantial benefits to and deserve substantial support from every employer in the community. Nor must the private or proprietary schools be forgotten. Various types of extension work, some excellent and effective, are available. The best of these are worthy of consideration for the special types of instruction or guidance in the organization of instruction in which they specialize. Schools are occasionally organized by manufacturers of special equipment, as welding, for the training of customers' employees.

CHAPTER SIX

Five Typical Training Plans

1. *Printing Company.* Several thousand employees. This company maintains a school for the training of apprentice printers. By arrangement with the local board of education, a private continuation school is operated in the plant. Boys are hired from the grades or the early years of high school, and continue their study of arithmetic, history, and other subjects, the only difference being that the illustrations and applications of the general studies are made in the field of printing.

At the same time, the apprentices are put through a thorough 4-year course of training in the printing art. A special apprenticeship is offered to college men; it takes a year to complete.

These courses are looked to as feeders for the skilled labor, pressmen, and compositors whom the plant employs. From the ranks of these men a substantial proportion of the executives of the organization have been developed.

2. *Textile Manufacturer.* Training of machine operators is left to the foremen. Attention is concentrated on giving assistance and instruction to the latter. This is done in several ways. The most formal of these is a monthly meeting at which the heads of the various shop departments discuss in turn the processes and problems of their departments. The meeting is participated in regularly by the factory manager and most of the time by the general manager, who use it as a means of "selling" their ideas and plans to the foremen.

In addition to this means of instruction, considerable emphasis has been placed on staff research and setting of standards of procedure, the staff men being responsible for qualifying the line men to carry out the recommendations adopted. The tendency in this shop has been distinctly to supplement the foreman by good staff assistance and to rely increasingly on technical control of the more involved manufacturing methods and processes.

3. *Electrical Manufacturers.* Force of about 600. An expert in motion study was retained for the winter. One or two operations, obviously possible of improvement, were selected and, in cooperation with the workmen and foremen involved, restudied and photographed in moving pictures, before and after motion study had been applied.

At the next regular monthly foremen's meeting these films were shown and the principles applied in them explained. Foremen were invited to submit other cases for analysis. The response, at first slow, became more enthusiastic as the foremen found that there were no "jokers" in the plan. Perhaps a certain curiosity to see oneself in the movies, and pleasure in the public recognition given at the meetings for good ideas and applications of principles, may have been a factor in the success of the plan. Wide interest was created, and the meetings were opened to any employees who wished to attend, as many as 300 coming out to one meeting.

At each meeting, a talk, arranged in series to give a teaching progression, was also given on the principles of motion study and the ways in which any operator could apply them to his or her daily work. Thus the shop ended the season and the drive, with possibly a hundred motion study "experts" instead of one. Care was used to make the lectures in motion study entertaining as well as instructive.

4. *Telephone Switchboard Operators.* New girls are interviewed, given physical examination, intelligence test, test in arithmetic, and similar tests. If hired, they report for classes and spend the first day or two in such work as a brief explanation and demonstration of how a telephone and a telephone switchboard work; practice in correct pronunciation of exchange names; correct phraseology and tone of voice to use in answering customers' calls. This is followed by more detailed demonstration and explanation of the parts and workings of the incoming call board, followed by several days at a practice board, in which one instructor gives the learner calls at a graduated rate of speed, increasing until proficiency is attained. The outgoing board is then mastered in exactly the same way.

Following this, the operator is given a position on a real traffic board, but with an instructor who handles a small enough number of girls so that she can give immediate help if the operator is for any reason flustered or falls behind the calls. After about two weeks of training, the operator is assigned to any exchange needing help.

5. *Automobile Parts Manufacturer.* A well-equipped school offers practically the equivalent of a college engineering course to selected candidates. Students alternate in 2-week periods between the various shops of the company and the training school.

The emphasis during the first two years is more on the applied and procedural courses than on theory, although the latter is not neglected. Some men leave the school for regular jobs after two years; others are encouraged to finish. A close cooperation is maintained at all times between foremen and the school. The foremen are informed of the student's record and stage of development and report on his progress.

The instructors in the school, including a group specialized in this work, also conduct systematic foremens' training courses and discussion sections.

WAGE INCENTIVES

AUTHOR
H. P. DUTTON
Associate Editor

THIRTEENTH IN THE SERIES OF

FACTORY MANAGEMENT and MAINTENANCE
PLANT OPERATION LIBRARY

CHAPTER ONE

Workers and Wages

THERE are evidences of a shift in viewpoint toward the problems of wage payment. Thoughtful employers no longer regard an incentive plan as a panacea that will solve all industrial ills. Those who have witnessed something of the development of management can recall a succession of cure-alls, to which industry seems to be peculiarly susceptible. Systems and costs (as conceived at that day) were the way to salvation 25 years ago. Then came scientific management, followed shortly by the wave of enthusiasm for "welfare" management. Welfare managers were turned out almost overnight to meet the need, and energetic club secretaries and nice old ladies carried the message of light for a brief and meteoric career of evangelism to hard-headed operators in, say, the cloak and suit trade.

Hunger for Formulas

The question of incentive plans has undoubtedly passed through the same phase, and has gratified that apparently insatiable hunger of human beings for a formula that will take the place of the hard work entailed in thinking.

During the depression all incentive bets were off in many plants. As a matter of fact, piece rates and bonus, if not completely discontinued in one way or another, were tacitly shoved into the background. Now, as the wheels begin to turn again, many employers are asking: "What shall we do about wage plans?"

Where Conveyor Sets Pace

It is significant that the emphasis is no longer on a formula. Many manufacturers have been slow to abandon their daywork arrangements and some may not go back to former incentive plans. There may be good reason for this attitude in some instances. In the much-discussed case of the Detroit automobile manufacturers, for example,[1] a paced conveyor system plus years of accumulated experience and records made it possible to set dependable standard operation times by which to measure performance. In an industry as seasonal as the manufacture of automobiles the question of priority in case of a lay-off supplies an effective incentive to give a performance at least up to the average.

We need not, on the other hand, reject the values of good wage incentive plans. Every wave of uncritical enthusiasm, whether for cost finding, scientific management, or personnel administration, has left behind it a solid residue of improved practice and increased efficiency. But in choosing a wage incentive plan it is going to be necessary in the years immediately before us to do more than declare our adherence to a particular formula.

Three Viewpoints

The problems of factory management may be approached from three widely different viewpoints. First is that of the trader, whose rule for success is to buy cheap and sell dear. Second is that of the engineer, whose driving urge is to put men and materials together into a machine whose gears will mesh and which will serve effectively the purposes of its creators and members. The third viewpoint, which for lack of a more accurate designation we might call that of the student of society, sees the industrial organization and the people who compose it as a community and, as such, subject to all the problems of reconciling partially divergent interests and making possible a harmonious carrying-on of the community activity.

Three Requirements

Corresponding roughly to these three points of view we may list three requisites of a good wage incentive plan:

1. The wage must be adjusted to the market price for the grade of labor for which it is paid. If the net amount of wages, by whatever system paid, is less than the employee can secure elsewhere, the employer will in time lose men, and particularly the men he can least afford to lose, to others who will offer them more. On the other hand, if the price paid for labor is higher, measured in labor cost per product rather than in rate per hour or year, than that prevailing among competitors, the employer incurs a competitive disadvantage which, if sufficient, may in the end cost him his business.

2. Assuming that the general level of wages is approximately correct, a second requirement of a good plan is that it shall effectively encourage performance on the part of

[1] See "It's Hour Rates in Detroit," Frank J. Oliver, *Factory*, January, 1935.

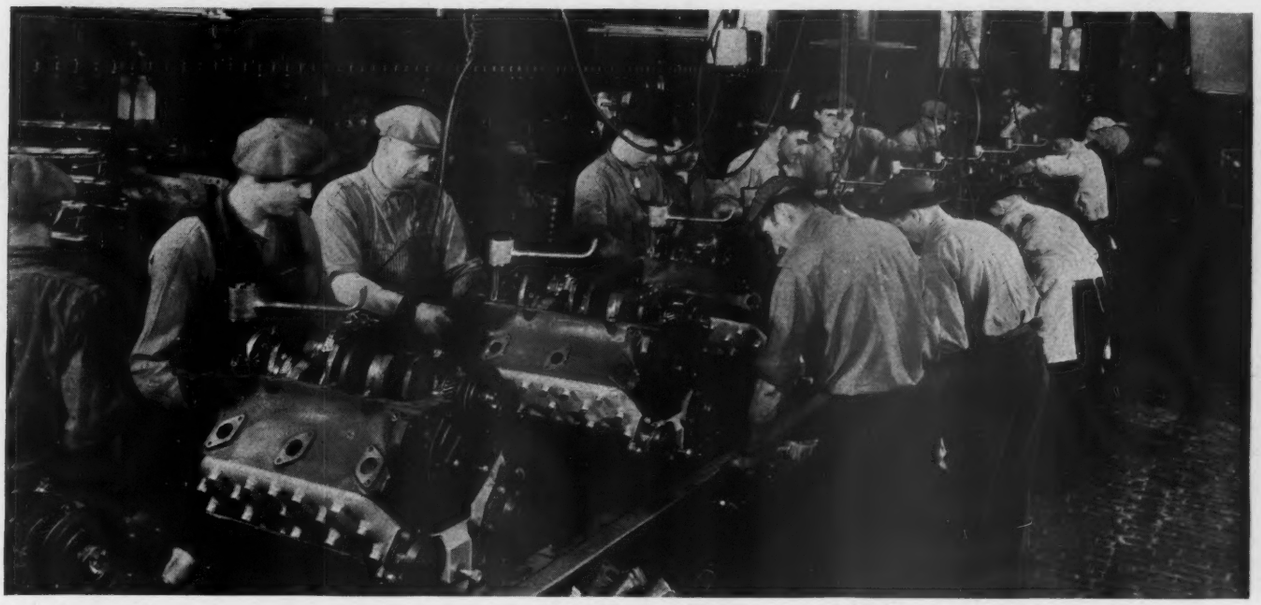
PRECEDING TITLES IN THE
PLANT OPERATION LIBRARY

1935

FOREMAN TRAINING . . . . . March
BUILDING MAINTENANCE . . . . . April
STANDARD COSTS . . . . . May
PRODUCTION CONTROL . . . . . June
MATERIALS HANDLING . . . . . July
INVENTORY CONTROL . . . . . August
QUALITY CONTROL . . . . . September
INDUSTRY'S POWER . . . . . October
MOTION ECONOMY . . . . . November
MAINTENANCE ORGANIZATION . . . . . December

1936

AIR CONDITIONING . . . . . January
EMPLOYEE TRAINING . . . . . February



Many manufacturers have been slow to abandon daywork arrangements made during the depression. Some may not go back to incentive plans. In the automotive industry, for instance, the conveyor sets the pace, and years of accumulated experience have made it possible to set dependable standard operation times by which to measure performance. In the photograph, the Ford V-8 motor nears end of assembly line

the recipient. In general this result is accomplished by tying the payment to the performance as in piece rate, so that the employee can increase his pay by increasing his effort.

3. The wage structure must be adjusted so that it is relatively fair within the organization. Achievement and superior effectiveness or faithfulness are recognized by wage increases, even though they may not be necessary to prevent a particular employee from leaving the organization to obtain a higher rate.

Individual Bargains

The third point would hardly have been conceded as valid by the employer of a few years ago. The custom was very generally to make an individual bargain with each man, preserving, as far as possible, secrecy as to wages or salaries. This attitude still prevails as to the higher paid and less standardized positions.

But in the lower levels of salaries and wages it is difficult to prevent knowledge of the subject from leaking out. The more aggressive, persuasive, and insistent employees tend to receive advances while those perhaps worth more to the company are passed by, very possibly eventually to leave for a better job they can get without argument. The wage structure thus becomes lopsided and inconsistent. There has been a very considerable movement in the last four or five years, accelerated by the opportunity afforded by the depression for equalization as an incident to general wage reductions to classify[2] positions systematically and endeavor to secure relative consistency throughout the organization, from top to bottom.

J. O. Hopwood in the May, 1935, issue of *Personnel*[3] lists, as a factor to be considered in setting wages, the distribution to the worker of a share in the income from production. I am not certain that one need go the full length in applying this principle, and probably Mr. Hopwood did not intend to do so. It would not generally be accepted that a company making large profits has an obligation to share these profits with transient employees, for example. Indeed, John R. Commons, one of the recognized authorities on labor problems, has expressed his belief that what workers want is not a partnership with management, either in profits or in risks, but the opportunity to bargain on terms of equality and to their best advantage.[4]

Yet most employers feel that the obligation, especially to older and more faithful employees, extends beyond the explicit contractual obligation. In the eyes of the law, the satisfaction of the contractual obligation meets all requirements; yet back of our present-day theories of the rights of independent parties to contract, lie hundreds of years of racial experience in communal relationships such as those of the master and journeyman who lived together in one family, or the earlier feudal system with its elaborate, fixed, customary responsibilities mutually between lord and liege, or similar systems patterned on the family relationship, which even today continue to be the dominant social relationship in some of the less economically advanced countries of the globe.

The older relationship is aptly distinguished by Sir Henry Maine as one of *status*, of recognized rights and duties fixed by custom, as distinguished from the present relationship in which all these matters are determined for each situation by the parties concerned on the basis of a *contract*.

Less Sure of Himself

In a rapidly expanding civilization such as that of this country in the last century and in the earlier years of the present one, the rigidity of the earlier order would have proved hampering and would have been abandoned. Nearly every employee thought of himself as an employer and desired the greatest

[2]See "How Much Is Skill Worth?" H. H. Tullis in *Factory and Industrial Management*, November, 1931.

[3]"Administration of Wages and Salaries," p. 99.

[4]*Industrial Goodwill*, John R. Commons, McGraw-Hill Book Co.

Above all, an incentive plan must be simple enough for the worker to understand—one that will enable him to figure what he has earned each day, and thus know what is coming to him at the end of the week

freedom to better his condition if he could. As the frontiers close and the competition becomes keener, the common man finds himself more alone and less sure of himself. He needs the support of an organization stronger than himself; it will seem less a sacrifice to him to give his loyalty to a strong company to which he may look for loyalty in return.

Many of the strongest and most experienced corporations in this country seem in one way or another to have recognized this situation and taken it into account in their labor policies. Profit-sharing, practiced either sporadically or systematically by several large companies, is a recognition of the feeling of partnership. Pensions and similar plans for the care of old employees, unemployment insurance plans, and the commendable make-work plans employed by many companies during the depression are examples of the feeling of responsibility, outside the contract and the law, of the employer toward his permanent force.

Nearly all employers recognize such obligations to some extent; the point is that some are coming to use this idea of a reciprocal and lasting obligation as a cornerstone of personnel policy.

In many instances these things are undertaken without thought of profit, simply because they seem to be the right thing to do. But rightly handled, they have also proved profitable, in the sense of building a more productive organization. For example, an executive of a large corporation recently remarked that no large company that had consistently followed intelligent labor policies for any considerable period had had any serious labor trouble during that period. And with few exceptions this statement will be found to be true.

Desire for Bargains

The viewpoint of the trader, if wage problems are approached solely from that point of view, is apt to over-reach itself. Low-grade employees are notoriously expensive for most types of work; the ability of American labor to compete with Chinese labor, for example, is due to the fact that, although costing perhaps ten times as much per hour, it has in the past at least been so much more productive that it was actually cheaper. The same is probably true at the present time in comparing Northern labor with the lower-paid grades of Southern labor for many occupations.

Even if the trader is an intelligent buyer of labor values, the man who looks at the problem from that angle alone is likely in his desire for bargains to lose sight of the value of a consistent wage structure.

An exclusive preoccupation with the viewpoint of the engineer is equally unproductive. Too great a concern with formulas is likely to lead to the development of plans that are difficult to understand and costly to compute. This viewpoint is also likely to over-emphasize one characteristic of workers and to overlook others just as important. Many plans, for example, rely solely on a stimulus to competitive, individualistic gain, and ignore the group inhibitions and group loyalties of the worker completely, or run aggressively counter to them.

Blueprint for Social Justice

Nor is the viewpoint of the student of social institutions a safe guide alone. If past experience is any guide, no plan is more certainly headed straight for failure than the blueprint for social justice which assumes that the responses of men are as we should like them to be, rather than as they are, or which ignores that old Chinese proverb, so applicable in economic affairs, "No tickee, no washee."

Profit-sharing plans, for example, in the older sense of a sharing of the profits of the firm rather than of savings resulting from the efforts of the participating individual, enjoyed a considerable vogue about 20 years ago. As a method of sharing prosperity with fellow - workers, profit sharing has its value, but experience has demonstrated that as a stimulus to increased effort or productivity on the part of employees its effects are generally negligible. It does, however, in the opinion of users, produce a feeling of friendliness and good will on the part of the employee who participates.

It would not be hard to produce even more recent and convincing examples of the difficulties that beset the individual who would reconstruct the productive machinery of industry from a social viewpoint without taking full account of human and economic realities.

What is wanted, in this difficult problem of wages, is a man or a group whose experience is broad enough to embrace all three points of view. This sort of man will approach the problem not solely from the standpoint of the trader who cares little what the other fellow thinks so long as he gets a cheap

price. Nor will he be so preoccupied with getting a plant to which his type of man would react perfectly, that he fails to observe the wide differences between his background, loyalties, and whole point of view, and those of the man who is really going to use the wage plan. Nor will he forget that he represents the employer in bargaining for a wage and that, while no bargain is a sound one that does not benefit both sides, the process he is engaged in is nevertheless bargaining.

Such a man will try to put himself in the worker's place, and not only attempt to reconstruct the worker's reaction from this theoretical standpoint but also to find out, by study of what has happened in other cases and by a little quiet investigation of the people he is working with, what the reaction really is. One employer, in considering a change of wage plan, went to his employees and asked them what they thought of the present plan. He found they preferred day rate, so he put it in. A most unusual procedure, but why should it be?

CHAPTER TWO

The Worker's Viewpoint

WHAT ARE some of the questions pertinent to wages and wage plans that are important to the employee? Let us see if we can list a few of them.

It will first be necessary to note the fact that there are many classes of employees, each with its own set of problems. A first distinction might be as to age. Young, unattached men and women, with the future all before them, and with slight present responsibilities and commitments, respond best to the positive stimuli, the pleasure and interest in the task itself, the rhythm and sense of pitting oneself against obstacles implied in hard physical work with a swing to it, the pleasure of association with other workers, or the appeal to the imagination of the career-building motive.

Sometimes, with young people still in their minorities, a very special peculiarity must be taken into consideration. Many young people turn over their earnings, or all but a fraction of them, to their parents. A bonus of $3 a week to Mamie may simply mean that Mamie's "old man" is $3 richer, through no fault of his own. Why should Mamie hurt herself earning it?

When Commitments Increase

As a man marries and approaches middle age, his commitments increase and he feels the pressure to let himself out and to increase the family income. Four weeks of good earnings would just about make the first payment on the car, enable him to have his teeth fixed, or to take out some insurance.

Although this man will expand his scale of living as fast as improved financial status permits him, he adjusts his expenditures to his income, usually crowding it a bit. A minority in almost any income class above the definitely submerged classes will manage to accumulate a reserve, to buy a home, or to put aside some money in a building and loan association.

Protection Necessary

Generally speaking, the workman cannot, however, invest as securely or as profitably as the man with greater reserves, more leisure, and more training and contacts. The problem of protective reserves for men of this group is among the most pressing before the nation and, whether or not we agree with the wisdom of the mechanism of the Social Security Act, we must admit that some form of protection has become a necessity.

Because of this uncertainty and difficulty of accumulating reserves, security of income, so lightly regarded by the young folks, becomes all-important to the older, settled worker.

Living in the Present

The career motive persists in a few members of this age group. Probably by the time the average worker has reached his middle thirties he has reached a static equilibrium in this respect. He has changed jobs enough times to find that advancement does not lie in this direction, although, like the gold miner who always wants to put in "one more shot," he has not wholly abandoned the hope of bettering himself in this way. But in the main, unless he works for a man who has the rare knack of putting some zest and romance into more or less routine activities, this middle-aged worker takes a mild satisfaction from having a responsible job with a good strong company. If he is a good worker and has a good boss he will probably get a good deal of satisfaction, although he may not be conscious of the fact, from the mere skillful manipulation of his tools, the ability to make machines and materials stand up and do tricks.

This type of man learns to live a good deal in the present, a very tolerable sort of life when the horizon is not too darkly clouded. Give him a steady wage, with the chance to increase it somewhat by "plus"

Why should Mamie tear her shirt to earn a bonus? A bonus to Mamie may simply mean that her "old man" is that much richer

performance. Leave the avenues of promotion open, not blocked by lack of adequate means of finding men in the organization or by wrong personnel practices. Even though only one in twenty or one in a hundred is promoted, the rest feel the way is open; they have no one to blame but themselves if they do not make it and some day they may make it.

As a man becomes older, security becomes the dominant motive. The older man may then become one of the most useful employees. Experienced, with a matured judgment, past the emotional upsets of youth and dependable, the older man may continue to increase in usefulness until his physical powers fail from old age. On the other hand, it becomes increasingly difficult for the average older man to re-establish himself after economic upsets, and after any one of these he may give up trying or be forced to surrender and become a dependent.

Although it is possible for the older man to continue to grow mentally and thus to adjust himself to the cumulative change that affects nearly all occupations, there is always the danger that at some point he may fall behind the procession and fail to catch up. Much can be done to assist the older man in preventing this occurrence.

A second classification is as to allegiance. There is and should be much common ground between employer and employee. They work together to make a product, and in considerable measure prosper or suffer together with the fortunes of that product on the market. But when it comes to the division of the profits of the common enterprise, at that point there is a bargain to be made and a difference of interest. The same difference exists between buyer and seller of the raw materials that go into the product, and its existence is not in that field, nor need it be in the labor field, a bar to cordial cooperation regardless of momentary differences as to whether the price is to be 10 cents a pound or 12, or 55 cents an hour or 60.

On the High Side

In the great standardized occupations, where rates depend much less on individual differences and individual bargaining than on general market level, there is little necessity or opportunity for argument with the firm that continuously keeps its wage rates, all things considered, at or slightly above market. But there are in most fields enough inefficient producers, or those with a mistaken wage policy, to make it possible for the firm that desires to do so to maintain a wage somewhat on the high side of the going rate.

Wages, in this sense, must be taken to include all the benefits that the employee values—security and regularity of work, congenial working conditions, insurance, investment privileges, cooperative buying, or special employee discounts in retail stores and the like. Many companies that habitually pay a wage slightly below the highest for an occupation in a community, nevertheless attract the workers they want because these indirect wage values more than balance the difference.

Conflict?

Attitudes of firms differ as to their relation in this respect to their employees. Some companies take the position that there is no conflict of interest, that the whole organization, from president to office boy, is integrally concerned in performing a service to the public and will be rewarded in proportion to that service. Other large companies, equally successful in their personnel policies, discuss frankly with their foremen both the points of common interest with employees and the points at which a bargain must be made and interests may come into conflict.

Of the two, the latter appears to be the more realistic and safer policy. The surrender by the employee of questions of wage increase to the discretion of management places a heavy responsibility upon the management that accepts it. It would appear safer, and equally effective, to admit in principle the difference in interest which unquestionably exists, and then to see to it that there seldom is in fact such a difference and that the channels for its expression are open if it exists.

•

The manager and the engineer are likely to think of the workman as a member of a group or class. Probably the average workman does not . . . Collective action, with its necessary surrender of some measure of freedom for individual action, its necessary averaging of individual initiative, is appealing only when it accomplishes substantially more for the individual than he can secure alone

Won't Join Unless—

Regardless, however, of the point of view that the management takes on this question, we are more interested in the opinion of the workman. The manager and the engineer are likely to think of the workman as a member of a group or class. Probably the average workman does not. A man may be carried away by a patriotic zeal to reform the existing order and, in the group of this missionary enthusiasm, may vote and think as a Socialist, a capitalist, or a prohibitionist. In so far as he is realistically considering his own problems, however, he will not join an organization or a union and pay dues so long as he feels that he can, with security, attain his personal objectives unaided.

Collective action, with its necessary surrender of some measure of freedom for individual action, its necessary averaging of individual initiative, is appealing only where it accomplishes much more for the worker than he can secure alone.

One would expect trade union membership to grow rapidly in periods of sharp readjustment of wages, either up or down, and to diminish in more stable periods. One would expect the unions to be strong in seasonal and otherwise unstable industries, and weak in those better regulated or organized. Such are indeed the facts, as regards defensive unionism, although they fail to take into account the unions that protect a highly organized group from competition with other labor.

If this point of view is correct, organized action by labor is resorted to as a means rather than an end in itself. Regardless of the workman's affiliation with a union or not, when we see him as a member of a group of workmen in the shop, we recognize strong social compulsions which should not be disregarded in dealing with wage questions or any others. No matter how fine the relation may be between workmen and their boss, between teacher and pupil, there is drawn between the two groups a fine line which may not be overstepped.

CHAPTER THREE

Restriction of Output

PROBABLY more difficulties with wage questions arise because of this fine line between employer and employee than for any other reason. Take, for example, the problem of restriction of output. Doubtless many managers feel that it is nonexistent or negligible in their organization, and they may be right. But repeated studies have shown restriction of output, and a strong shop opinion supporting it, in some of the most enlightened and efficiently organized industries in the country. It is a form of group protection against the boss, and the workman who ventures to flout this unwritten law is ostracized by his companions.

Guerilla Warfare

In one thoroughly enlightened company, whose rate-setting departments were far above the average in competence and fair-mindedness, confidential interviews disclosed a very general belief in the necessity of output restriction. A serious-minded workman who saw no reason why he should not let himself out and increase his earnings, was ridiculed, twitted, and given a feminine name by his fellows. Even the lower ranks of foremen were found to sympathize with and tacitly support the convention of output restriction.

The engineer in particular finds himself helpless in the face of this organized opposition. The engineer, like most foremen and white-collar men, takes the point of view of the management. To him every increase in output is right, a social gain as well as a means of personal advancement. He finds it hard to sympathize with or even tolerate an obstruction to this objective. Because of this lack of common ground, the situation is apt to resolve itself into a sort of perpetual guerilla warfare on this question, perfectly compatible with workable and even cordial relations on other points. One can imagine the men saying to themselves: "Well, the boss is a pretty good fellow in most ways, but he's hipped on this rate question."

Back of It All

There is a long story back of this particular point of difference, but it it is one that the man responsible for wage policies and methods ought to understand.

The first and most obvious element is the fact that when the time-study man is determining a standard time, he is not only, as he sees the operation, making an objective and scientific observation, but he is also bargaining with the man. There may be and doubtless is, from the physiological viewpoint, some optimum point of effort and performance which would constitute a correct rate of output for each individual.

Obviously no single time would be theoretically correct for all; there would be many correcting constants for difference in physique, state of health, reaction time, time of day, and an infinitude of other personal and local differences. However, the concept of an average performance with a flexible and automatic adjustment of earnings to individual differences, so that the average man would earn an average wage at a normal effort level, is defensible on theoretical grounds. How far the average time-study man is from realizing this theoretical perfection of observation is known to any careful analyst and has been the occasion of well-deserved comment by one such observer.[5]

A great deal of controversy would be cleared up were the level of a "fair day's work" scientifically determined and known to all workmen and managers, and used as a common denominator in setting tasks, leaving for determination by bargaining only the question of how much the time and skill of the individual were worth.

An assembly department at Hawthorne Works, Western Electric Company, Chicago. Brief account of this concern's experiments in effect of working conditions and incentives on output is given on page S-212

But workmen do not yet generally accept the idea that the level of output can be scientifically determined. There has been too long a history of unscientific determinations. Piece rate is one of the oldest wage systems and one of the most widely used, and time standards for setting piece rates have for generations been determined by a sort of guessing game. The management took the existing level of output and guessed that the men could stand a 30 per cent increase in output. A rate was put into effect that increased earnings enough to constitute an inducement to give the expected output. Usually it was found that the possibilities of increase had been grossly underestimated, and presently another experiment was tried. When the men found that, no matter how

[5]See "A Psychologist Looks at Incentive Plans," R. S. Uhrbrock, published in 1935 by the Institute of Management.

much they increased the output, their earnings were always cut, there was no further need to demonstrate to them the wisdom of restriction of output. Quite naturally, anyone silly or greedy enough to disregard the interests of his fellows and "hog the rate" was outlawed.

Nor was this a satisfactory situation for the factory manager. He wanted to play fair in most cases, although competition and the knowledge that the output was there if he could get it forced him into an inconsistent position. As the technique of time study was introduced, he was encouraged to feel that here at last was a solid foundation for rates. In many cases he had sufficient confidence in the rate, in fact, to promise his men that it would not be cut, so long as the methods of performance was unchanged.

Can He Keep It?

This promise is undoubtedly given in good faith. But can it be kept? Evidently, unless the rate really gets at the theoretically correct time, a thing difficult to do in the light of present knowledge, the same necessity will presently exist to cut the rate. The device of changing the job may technically avoid broken promises. The employer may maintain the rate, but if he does so it is with the knowledge that, having found the possibility of a faster performance, he can at any time hire a new workman and break him in at the lower rate, and that his competitor, if he learns of the condition or discovers it in his own plant, will probably undersell him.

The situation is still unstable, and has been improved only to the extent that the guesses are better. The technique of stopwatch time study is not sufficiently refined to enable an observer who has no experiences with other, faster performances to predict, from observations on a man who has accustomed himself to a certain speed of performance, how much faster an operation should be performed.

Motion study offers somewhat better prospects in this direction. The careful building-up of a process by critical analysis of its elements and their arrangement for best performance, and the more detailed knowledge of small elements or therblig times which is bound to be developed and is developing, all promise a greater certainty in the setting of accurate task times. Incidentally, the results so far secured in motion study indicate that the whole question of exact effort level to be expected may be relatively sterile and insignificant compared with the responsibilities of eliminating waste effort by teaching and developing better methods of performance.

Mutually Conducted

Where such detailed and painstaking studies are made, as they should be, with the cooperation of the worker under observation, so that the study becomes a mutually conducted investigation rather than a bug-under-the-microscope proposition, the relationship is also much better, and both parties to the bargain know pretty definitely the fairness of the time arrived at. Even though such thorough studies may not be required for every job, they offer the possibility of setting up datum points by which to judge the accuracy of other studies.

Another difficulty with the concept of a correct time of performance is the fact that the curve of effort is roughly like that shown in the accompanying figure. We have no record of a human being who has run a mile in less than 4 minutes. The effort required for this rate of performance is infinite, so far as humans are concerned. Very few men have run that distance in less than 4:10. Almost any man in training can do the mile in less than 5 minutes. It would actually be harder to keep up the running gait, as distinguished from walking, at a 15-min. rate than at a faster pace. What point on the rounded curve, a curve almost flat at its lowest levels, is the scientifically correct one? When we consider the evaluation of mental operations, of the work of the salesman or the foreman, we must admit that we are still a long way from the engineer's conception of a scientifically correct time.

The sooner the time study man ceases to look upon the worker as a sort of bug under a microscope, the better his chance of arriving at fair times

What factors, then, do determine the time a man takes for a job? Habit is one. He has learned the job in a certain way and at a certain pace. You will have to show him good reason why he should change that habit.

Back of habit lies custom. In a particular shop, the pace at which the majority of the workers perform a job comes to be regarded as "a fair day's work." To a workman not wholly convinced of the precision of time-study observations, the pace is a matter of bargaining in the same way that the rate per hour is. True, from the long-time standpoint, an increase of productivity with no increase of effort, no cost in injurious fatigue or sense of strain, is a net gain. But it is not in general a very direct gain to the particular workman who delivers it.

How Measure Effort?

As has already been indicated, the tendency is distinctly for the pay in the long run to be the same for the increased effort as for the old, unless the increase calls for unusual skill or abilities that raise the job to a higher-skill class. Usually, in the long run, the improvement in method or effort becomes common property, and the workman benefits only as a consumer. Of course, small though his gain may be from his individual contribution to the betterment of the art, the worker as a class has been the greatest beneficiary of the aggregate increases of productivity from such improvements.

But in view of all the uncertainties about a truly scientific output level, in view of the repeated, almost traditional disappointments of labor, one can understand and might as well reckon with the instinct to restrict output. Management will continue, as in the past, to endeavor to increase productivity; competition will compel it to, and it is to the long-run social interest that it should. But management will do a better job if it recognizes the limitations of its tools, does not make promises in ignorance of economic facts which may make it impossible to carry

them out, and does not yield to an irritation because the employee has a different point of view.

In time, the goal of a much wider knowledge of how to measure effort and performance seems attainable. Every advance of our knowledge in this field removes something of the controversial element inherent in the present more or less trial-and-error determination of rates and effort levels.

No New Formulas Wanted

It is readily seen, however, that an inflexible insistence on the attainment of output levels in whose determination the workman had not been consulted, and with whose principles he was not in sympathy, is likely to inject an active irritant into industrial relations. If there is any improvement possible in the administration of incentive plans, it probably lies, for the rank and file of companies, in the direction of a greater frankness, a more inquiring and cooperative attitude, on the part of those charged with wage administration, rather than in any new or more elaborate system or formula. As a matter of fact we have too many formulas now.

Nor is this requirement for discussion, explanation, and justification of wage proposals satisfied by distributing a printed explanation or holding a mass meeting at which management does all the talking. The way should be open for a reconsideration of any rate that a man may consider unfair, and in making a time study or setting a rate, the workman should be made a party to the proceedings at very least to the extent of being consulted as to method and working conditions, and of understanding the procedure by which a rate is made.

CHAPTER FOUR

What Is the Job Worth?

WITH THIS general discussion of principles and point of view as a background, we may briefly review the procedure for determining how much a particular job is worth. Various attempts have been made to relate wage payments to the cost of living. This factor may very properly be observed, as an indication of any acute maladjustment which the company should remedy. During the rapid rise in prices of 1919, following the war, so much distress was caused to those on salaries and fixed incomes that some sort of relief became virtually necessary and, furthermore, was made possible by the higher prices most companies were receiving for their products. As a general principle, however, this method of fixing wages contains the fallacy that, were it to be practiced by all employers, the cost of living would become a spiral without upper limit.

Supply and Demand

Differences properly arise in an organization as a recognition of individual differences in productivity and accomplishment. It is, consequently, not correct to make without qualification the general statement that wages are fixed by supply and demand. However, supply and demand factors form the basis of the wage structure. Firms that find it easy to get help at the rate offered may lower the hiring rate, or raise it if the reverse is true. Many employers exchange information as to the rate paid for typical occupations, to keep themselves informed and their rates in line.

If such information is systematically obtained and checked with the rate structure, especially during times of changing rates and prices, there will be less danger of being caught with rates badly out of line. Trends may be seen and anticipated.

A question that has engaged the attention of many industrialists recently is the classification of occupations. The American Rolling Mill Company[6], for example, has been at work for several years in establishing and maintaining a systematic classification, and there have been a number of other conspicuous examples of the same practice.

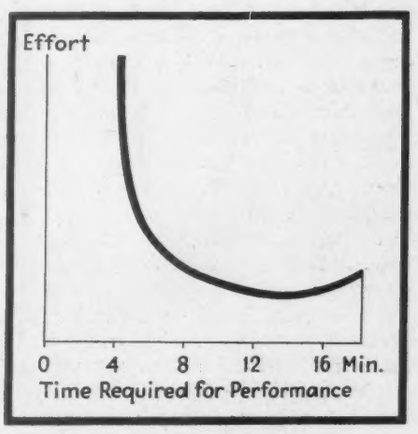
Such classifications are justified by the tendency of the wage structure, when allowed to grow of itself and by the uncoordinated actions of the various supervisors who grant wage increases, to grow more and more illogical and out of line. Differences of as much as 100 per cent were found in the American Rolling Mill plants, between the rates paid in different departments, for the same occupation. In another company, men with a base rate of 46 cents per hour were averaging per hour on piece rates as much as another group whose base rate was 80 cents.

What Is Skill Worth?

In beginning a rate classification, a common procedure is to prepare a card for each employee, listing his name and number, title, the name of his superior and the names or number of his subordinates, his present rate of pay, and similar pertinent information, and then describing his duties in detail. Usually the individual makes out the card for his own job, and his supervisor checks and comments on his statements in a space provided on the report.

The next step is to sort these cards into classifications based on the grade of work or occupation description, disregarding the rate of pay or title the man may show on the card. This work should be done by a committee of men familiar with the occupations and as far as possible with the employees under consideration.

This step looks to the putting of all occupations into certain pay or skill classifications, ranging from the lowest paid and most unskilled occupation to the highest included in the classification—the president of the company in some cases, but more commonly the factory manager, chief engineer, and ranks as high or



A difficulty with the concept of a correct time of performance is the fact that the curve of effort is roughly like the one shown above. We have no record of a human being who has run a mile in less than 4 minutes. Effort required for this rate of performance is infinite

[6]See "What is Skill Worth?" H. H. Tullis, *Factory and Industrial Management*, November, 1931.

	Maximum Points
1. Supervision exercised by operator	5
2. Judgment required by operator as to quality of product	10
3. Responsibility for material and quality	20
4. Responsibility for equipment	5
5. Manual dexterity	15
6. Working conditions (dust, heat, etc.)	10
7. Hazards	5
8. Physical requirements	5
9. Educational requirements	5
10. Learning period	20

Point system of classification, using ten factors to rate jobs, enabled The B. F. Goodrich Company to arrive at eminently fairer base rates

higher. For these grades appropriate salary or wage ranges are established. The number of grades will be determined largely by convenience in arranging a series of suitable wage steps. The number may range from 8 to 20 or more. Carl Barth has suggested the use of a preferred number series for a logical salary range.[7]

Ten Rating Factors

In assigning jobs to the appropriate grade in the classification, a list of factors is taken into consideration. One company[8] considers the following factors: Supervision exercised by the operator; judgment as to quality of product; responsibility for material and quality; responsibility for expensive equipment; manual dexterity; working conditions, such as disagreeable conditions; hazards; requirements for physical size, weight, and similar qualities; educational requirements; the learning period required. (See accompanying table.)

Another classification[9] lists supervision exercised and received, responsibilities other than supervisory (as for yield, quality, or damage to equipment), capacity to train for the job ahead, dexterity, physical requirements, working conditions, education and experience, and connected expense (the investment necessary by the employee in tools, clothing or incidental expense). Still other lists include, in addition to many named above, the degree of intelligence required for the job, whether "A," "B," "C," or "D," using the familiar school rankings, and the difficulty of replacing the employee.

For each zone or classification a permissible range from minimum to maximum is usually then established. These ranges determine the limits of wage increase within the authority of immediate supervisors; normally it is expected that further increases shall be earned by the individual by qualifying for promotion to a higher classification. Piece rates are set, in connection with such a scale of basic occupational rates, so as to allow the average worker to make an increase of from 10 to 20 per cent above base; exceptionally capable workers will of course be able to do better.

Such a classification should be scrutinized by a number of people and given considerable study before it is approved. It is advisable to discuss it with employees' representatives in companies having employee representation plans.

Value to Organization

The benefits of such systematic classifications are evident. In so far as they are the result of judgment of individuals as to the value of different types of skill, rather than a reflection of going market prices for the grade, classifications of this sort are subject to a theoretical objection applicable to any effort to fix prices by fiat. There is a danger that the logical rate structure may get out of alignment with the realities, which are not always logical, or which obey influences that may not have been sufficiently considered by the rate makers. However, market levels are only the starting point in wage determination, and a classification gives order and consistency in those numerous cases in which the decision is governed not by competitive offers but by the value of the individual to the organization. And a good classification takes market rates into consideration.

[7] *Cost and Production Handbook*, pp. 596 and 649.

[8] See "How Much Money for How Much Work?" by H. Resseger, *Factory*, October, 1934. (The B. F. Goodrich Company.)

[9] C. H. Murray in *Personnel*, November, 1934, p. 39. (American Rolling Mill Company.)

CHAPTER FIVE

Relating Pay to Performance

IF WE assume a consistent wage level structure and a wage correctly related to the general market levels, the next problem is to secure the connection of the payment to the performance in such a way as to secure the most effective stimulus to output by the payment of the wage. Pay is only one of the stimuli to output to which a normal man responds. But it is an important one, not only because it measures the extent of his enjoyment of material possessions, necessities, and pleasures, but because it is also to a considerable extent a measure, in the eyes of the man, his wife, and his friends, of his importance, rank, and success in a material sense.

Straight Piecework

How connect pay with performance? The man sells time, skill, and effort; the employer buys output. Where a measurable effort will produce a measurable output, the oldest and most practical plan of payment is straight piece rate. Under suitable conditions no system of payment surpasses it in effectiveness or fairness. It is one of the simplest of systems to administer and account for; it is ideal in connection with modern standard cost development. Any workman can understand it, and from day to day and hour to hour translate the progress he is making in his work into terms of tangible, specific earnings. It puts the man into business for himself, giving him a full return for every ounce of effort exerted. Because the problems of the man coincide with those of management, both being interested in greatest output, problems of discipline and malingering, always present to some extent with time payment, practically disappear.

The simplest type of piece rate is that in which just one type of performance, the production of a specific article or completion of a specific operation, is paid for. But there is no reason why a variety of performances should not be included in the contract.

A Way to Check Waste

In one case, for example, blocks of sheet mica were to be split into thin laminas of uniform thickness. Straight piece rate was being paid, and was proving expensive because the operators, in their desire to increase earnings, wasted a good deal of the costly mica in their haste. The plan of payment was revised. Payment was for output as before, but the rate per hundred was based on the percentage of mica turned in as finished work by the operator. The higher this percentage, the higher the rate per 100 pieces.

Straight commission selling is a plan of payment somewhat analogous to piece rate. It differs in the fact that results do not automatically follow from the exertion of effort but rather follow a percentage or average relationship which may be accurate only over a large number of efforts.

In selling, a plan that has met with a good deal of favor is the so-called point system. Many kinds of activities may be desired of a salesman. It may be to the firm's interest for him to collect some accounts past due, or to spend time showing a retailer how to display and sell the merchandise, or to make up prospect lists, or call on customers who have stopped buying.

Eventually, Not Now

Any one or all of these activities may have an eventual beneficial effect on the salesman's commissions as well as the firm's business, although there may not always be such a relation. But, to a salesman who is not sure he will be covering the same territory next year, they may look like an unprofitable use of his time. Or to take another illustration, the salesman whose commission is based on volume will gravitate toward the items easy to sell, usually those on which the firm's profit is low, while the new lines, hard to sell, or the highest priced lines on which the profit is larger, are neglected.

In each of these cases the criticism of a straight commission system of payment is that the payment is not proportioned to produce the desired effort. The salesman is being asked to do some things for which his pay is less per unit of effort expended than it is for some others. Now a salesman on straight salary, in these circumstances, can have no objection to any reasonable use of his time that the employer may desire. Barring a few disagreeable jobs which he is likely to try to put off as long as he can, the pay for one type of effort is the same as for any other.

Proportioned to Performance

The point system meets the difficulty by basing the pay, not on the single inadequate measure of volume of sales in dollars, but upon a scale of values proportioned as nicely as may be to the desired performance. The difficult sale carries a larger number of points per dollars of sale than the easy one. The missionary work is appraised as to the time it takes, so that as many points are earned as would be earned by devoting the same time to selling. And so on, through as many types of performance as it may be desirable to differentiate, within the limits of reasonable simplicity.

Girls work in threes in the Trenton plant where La Coronas are made. A bunchmaker keeps two rollers busy

Family Resemblance

Many applications of the same idea are possible, in many kinds of work, in office and field as well as in shop. All bear a family resemblance to piece rate in principle.

Piece rate, however, and similar plans of paying for performance, are not suited to all conditions. For a piece rate to be satisfactory to both parties, it is necessary that the performance and effort required for it shall be definitely measurable. This condition cannot be practicably met where there are severe inherent variables in the work that cannot be averaged equitably over the whole performance. A price per piece, for a job that includes a large amount of set-up time on the part of the operator, will prove most unsatisfactory to both parties when the size of the lot is variable.

When the lot is small, the time required for set-up will make the job unprofitable and objectionable to the worker. When the lot is large, an unnecessarily high price will be paid by the employer. This particular difficulty is easily settled by paying separately for set-up time. The difficulty will not arise where lots are of uniform size and the set-up allowance can be included in the rate, or is trivial in comparison with the usual operating time.

Another illustration of an unsatisfactory situation for piece rate is in coal mining, where the operator is sometimes paid a tonnage rate for the good coal only, and has to remove the rock at his own expense. Holding a job under such circumstances may be considerable of a speculation.

When Piecework Won't Work

Piece rate is also unsatisfactory where any other hazards than those under the worker's control may seriously affect his output. Where a man must wait around for work, where there is frequent machine trouble or different lots of material vary, there the straight piece-rate plan is likely to be troublesome. The same is true when, because of the impracticability of making careful studies of the job under representative conditions, it is necessary to set a rate without a dependable timing. In such cases the difficulty is usually corrected by making an allowance to

the worker, but such allowances consume clerical and supervisory time and constitute a point of possible dispute or abuse.

Guaranteed Rate

Where the uncertainty is one properly chargeable to management, the usual and proper remedy is the use of a guaranteed piece rate, the worker receiving pay for output, but in no case less than his hourly pay would be for the time. A guaranteed rate may be used with beginners to encourage them to persist through the initial period of low earnings.

For salesmen it is more and more recognized that straight commission is not the most desirable form of payment except in certain special cases such as the employment of transient salesmen for whom the company takes little responsibility, and in whose training and supervision it makes a minimum investment and prefers to take a minimum risk.

For regularly employed men, earnings are often affected by seasonal factors and while the income over the year may be satisfactory, the violent seasonal fluctuations are disturbing to the man's domestic economy, encouraging extravagance in some months or periods, and causing anxiety, depression, and reduced efficiency in others. In all such cases a guarantee of at least a minimum monthly income, with a perhaps somewhat lower commission or piece price if necessary, is apt to be a better plan than straight piece rate or commission. There is no occasion for this protection, however, when the conditions under which the work is done are constant, and the man's effort is the only variable in his earnings.

More Output, Less Quality

Piece rate implies inspection, and a definite specification of the quality of the performance to be delivered. Otherwise there is the temptation to increase the output at the expense of quality. It may be said that this is normally a temptation only to a small minority of workers; the majority, so long as they feel that they are being fairly treated, will return in kind. But where quality is not closely defined and checked, there is always the possibility of a progressive departure from the desired quality.

Generally speaking, all work should be inspected before it goes to the customer; carelessness or error is as possible to the man on day rate as to the one receiving piece pay. But the need of inspection to accompany piece-rate payment is generally recognized, and where for any reason it is impossible to inspect adequately, and important that the work shall be dependable, all attempt at incentive payment is sometimes abandoned and the work is paid for at straight time rates. Any bonus or other incentive plan which is effective as a stimulus to output suffers the same need for inspection as does piecework.

A variant of piece rate is the allowance of a standard time for the job and the payment of the hourly rate for the allowed time, regardless of the actual time. Thus if the allowed time were one hour, the rate per hour 60 cents, and the actual time 40 minutes, the payment for the job would be 60 cents.

Time, Not Money

This plan, 100 per cent bonus, while similar to piece rate in its general effect, has one or two differences. Since the standard is stated in terms of time, rather than money units, a change in base rates, whether by raising or lowering, does not affect the standards, nor require the large amount of careful clerical work needed for the revision of piece prices under similar conditions.

A further advantage, in some cases, is the fact that variations in general value of a man to the company, difficult to recognize with piece rates, can be taken care of. Under piece rates the only advantage the dependable, long-service employee may have over the last man hired, is whatever superior dexterity he may possess. With 100 per cent bonus, any such difference may be recognized by an appropriate difference in base rate. The older employee then gets 60 cents, perhaps, for the same job which pays the new man 55 cents.

There are limits beyond which rate differences may become unfair discrimination, but so long as the differences are kept within fairly narrow limits, the plan has an advantage. The 100 per cent bonus is little, if any, more complicated from the payroll standpoint than piece rate. Jobs are recorded in terms of allowed time, which can be extended for the pay period at the base rate in a single computation. Actual time, as in piece rate, need be checked only to verify attendance. From the standpoint of costs there will not be the same uniformity as with piece rate, but the variations will be slight and tend to be constant since they result from the very slowly changing ratio of high-rate to low-rate men.

Advantages of Piece Rate

As has been stated, piece rate or one of its near relations is from any standpoint the best wage plan under suitable conditions. Compared with any of the intermediate bonus plans, it offers the fullest incentive to output, is the simplest system to administer, and the fairest and clearest to the employee.

Piece rate, however, once fell into very bad repute, not so much because of the defects of the system itself as of the inaccuracy with which tasks were determined and the consequent temptation or necessity to cut the rate. In an effort to meet this difficulty, a large number of bonus systems have been developed. One of the earliest of these, the Halsey plan, simply proposed to allow a time for the performance of a task and to give the man some proportion, often half, although various other percentages are used, of any saving made over the standard time. If, for example, the allowed time were 1 hour, the hourly rate 60 cents, and the actual time 40 minutes, the pay for the 40 minutes would be the hourly rate of 40 cents, plus a bonus of 10 cents, the payment at the regular hourly rate for half the time saved, or half of 20 minutes in this example.

Point Plans

The 100 per cent bonus is a variant of the Halsey plan in which the percentage of saving given the man becomes 100. Related to the Halsey plan in general principle is another plan, the point plan, which has been widely used, the Bedeaux plan being one of the earliest and most popular of this type.

In the Bedeaux plan, the general procedure is to set an allowed time. Usually, if the actual observed time for a task is an hour, the allowed time is 72 minutes, the extra 12 minutes constituting an allowance for fatigue and interruptions, and enabling the operator to earn better than day rate for the task. The allowed time is stated in *"B's,"* or time units of 1 minute each. If the operator performs the task in less than the allowed time, he is credited with the *"B's"* saved, the actual credit being determined by a com-

parison of the total allowed and actual times for the pay period.

The operator is paid at his regular hourly rate for the time worked. For each *"B"* earned or credited under the arrangement, he is paid at a rate equal to three-fourths of his regular hourly rate. If this rate is 60 cents and the time of performance is 40 minutes, the operator is paid 40 cents for time worked plus 15 cents for 20 *"B's."* The plan also provides that pay for the remaining quarter of the time saved, shall go into a pool to be divided among the supervisors, for their part in making the increased output possible.

Simple in Principle

It will be seen that, except for the payment to supervisors, the Bedeaux plan bears a close family resemblance to a Halsey plan with a 75 per cent premium. Either the Halsey or the Bedeaux plan requires more extensive record keeping and computation than straight piece rate. Although comparatively simple in principle, one sometimes hears the objection from workmen that they are hard to understand. This is probably not a common objection, but it is harder for the workman to keep track of his hour-to-hour earnings.

Either plan gives a variable cost. So far as the problems of supervision and inspection are concerned, their effect is about the same as piece rate. Other point plans resemble 100 per cent bonus, the full rate being paid for each minute saved over allowed time.

Day Rate Plus Premium

A plan that has had a limited application for a number of years is the Rowan plan. This plan pays day rate for time worked, plus a premium equal to the percentage of time saved. Thus, with the same allowed time of one hour and rate of 60 cents used in the previous examples, a man who did the job in 40 minutes would be paid 40 cents for time worked plus 20/60 or 33⅓ per cent, the ratio of time saved to allowed time, giving a total pay for the job of 53⅓ cents.

Compared with Halsey 50/50 premium, the Rowan plan will be found to pay somewhat more liberally for savings up to 50 per cent. The plan has the peculiarity, useful in case very bad mistakes have been made in setting the standard time, that beyond a saving of 50 per cent over the allowed time the rate of pay per piece decreases rapidly. Under no circumstances can the man earn more than double his hourly rate.

Compared with piece rate, the Rowan plan is more difficult to explain or justify to workmen and is more difficult from the standpoint of payroll procedure. Its chief recommendation is the self-limiting feature, which makes it a safe system to use in any situation where little reliance may be placed in the available performance times.

Seventy-nine holes in the Ford V-8 engine block are tapped simultaneously

Other Plans

Many other plans have been proposed. Some of them have been widely used. The Emerson plan pays day rate up to a performance of an efficiency of 67 per cent of the standard or allowed time. From this point to 100 per cent efficiency, an increasing percentage of bonus is paid, somewhat arbitrarily determined by reference to a curve showing for lower efficiencies a very small bonus which gradually increases as the efficiency increases. At 100 per cent efficiency, the bonus becomes 20 per cent; above this efficiency the man is paid the allowed time for the job, plus a bonus of 20 per cent on the time worked. The Emerson plan has the advantage of offering some incentive even to very inefficient operators and encouraging them once they have earned some bonus to go out for more. Assuming the same constants in determining the standard time, the plan offers an even greater incentive than piece rate to increases in output.

In spite of these various advantages, the Emerson plan is rather complicated to explain or compute, and has been less used in recent years. A variation of the Emerson plan, the Wennerlund plan, has been widely used by General Motors.

One of the earliest modifications of piece rate to be proposed was the Taylor differential piece rate. Seldom used now, this plan set two piece rates, one a low one for the operator who failed to reach standard rate of performance, the other a higher rate per piece on attainment of standard. The objection to this plan is its punitive feature. Not only does the slower operator have to give more time to getting out a piece, but he receives less for it.

A plan used to a considerable extent in the tailoring industry, particularly in paying cutters, might be called the variable monthly rate plan. Cutters who maintained a certain output of garments during the month received for the following month a certain rate of pay, say $40 a week. If they fell below this output or increased it during the following month, their pay would be adjusted accordingly at the end of the month. The plan bears some resemblance to piece rate.

Among other plans that might be mentioned are the Gantt and Barth plans, the former a modification of the Taylor differential piece rate plan and the latter a proposal, interesting although little used, to compute the earnings as the square root of the product of the actual hours and standard hours, this quantity (the square root) being multiplied by the rate per hour. This formula gives an interesting and very logical variation of earnings with output. Although not impracticable of computation by slide rule, the formula would be a difficult one to explain to a workman, or for him to use in checking his earnings.

Probably for practical purposes the great majority of situations may be met by straight piece rate or its variants, by day rate, or by some form of the Halsey principle which provides a wide range of intermediate forms, with the Rowan plan to meet special cases of very unreliable standards.

Rules That Guide Choice

How may a choice be made of a wage formula? Certain general rules may be helpful in guidance.

1. The basis of a good incentive plan is the accurate definition and measurement of the task, either in simple or in

practicable compound units. Where definition and measurement can be done with certainty, piece rate or 100 per cent bonus will usually prove to be the best plans. The Bedeaux plan, using a 75 per cent bonus, is a near approach to piece rate in practice but lacks its simplicity. The provision for an incentive to foremen is a desirable feature but may be provided in other ways. With the modern tendency to increase the investment in equipment per man and the consequently increasing machine charges, there is a stronger and stronger economic reason for giving the man every incentive to full productivity.

2. Where precise definition of the task is impracticable, or where there are inherent variables in the operation beyond the man's control, the situation may be met in one of two ways. One of these is the use of a guarantee of day wages, usual with the bonus plans and often employed with piece rate. A second possibility, by way of protection of the employer, is the use of a plan that automatically reduces the price per piece as the rate of output increases, while at the same time increasing the rate earned per hour. The Halsey, Rowan, and Barth plans accomplish this result, the Halsey plan most simply and the Rowan and Barth plans perhaps most securely. The Halsey plan is probably the better suited to a shop where general methods and job times are well established but rates must be set on short turns or special jobs where thorough time studies are not justified or estimates must be used. The Rowan plan would be the safest where it was felt that the general pace of the shop was slow and there was no reliable basis for estimating the probable improvement. Either of these plans might be used as a transition plan from day rate to piece rate, since either automatically secures some improvement of output, frequently a large improvement.

3. Bonus constants may be adjusted to emphasize certain desired performance developments. For example, with a group of unskilled or slow operators who have a long way to go to reach the expected normal performance rate, the choice might well be a Halsey plan with a rather loosely set allowed time and a low rate of bonus, a half or even a third. Under this plan, workers would find it easy to commence to make bonus, while the low rate would allow the improvement to continue for a long time without an excessive increase in labor cost. On the other hand, with skilled operators, a tight rate would be set and a more liberal bonus, perhaps 100 per cent or piece rate, might be used.

CHAPTER SIX

Group Payment Plans

IT REQUIRES little modification to apply a plan of payment, suitable for an individual, to a group. Several reasons favor payment to a group rather than to the individual, under certain circumstances. For one thing, the fact that all members of a group share in the common bonus or earnings encourages mutual helpfulness. It was the experience of the Wahl Company, for example, that when packing and shipping pencils and pens were put on a group bonus, a girl whose work was slack for a few minutes would move over and help one who was piled up for the moment.

On day work there was considerable less alertness to keep the work moving. It is possible to bring janitors, repair and set-up men, and various types of helpers usually classified as indirect labor in for a share of the group bonus, with the result that everybody is alert to lend a hand.

The group bonus plan also tends to remove an objection often made to individual incentive plans and touched upon in the earlier portion of this paper—the feeling on the part of some workers that bonus and piece rates tempt the individual workman to betray his fellows. The sentiment will be found even in some group plans.

Worker Reactions

Reactions toward a group plan are likely to resemble the reactions toward a labor union. The man of superior capacity is likely to feel that his ability does him little good, that he is working for the others, and is held back by them. On the other hand, some members of the group are likely to slacken effort a bit and let the other fellow earn the bonus for them. Unless the group is too large for effectiveness, it usually finds ways of bringing such people into line or getting them out of the group.

In group payments, a piece price may be set for the task. The group is paid only for finished and accepted pieces. Where the units built are large, this may mean that earnings fluctuate somewhat from week to week due to variations in the group's inventory of work in process. Or an allowed number of hours may be set and one of the various bonus plans applied.

Where Group Plan Works Best

Usually the total bonus or piece rate earned will be divided among the group, in proportion, first, to the number of hours worked (usually but not always the same for all members of the group) and, second, to the base rate of pay. If a percentage is earned, the man at 60 cents base rate will get his hourly pay plus the earned percentage of bonus; the man at 40 cents will get a like percentage increase on his time earnings. In piece rate, suppose the price for the job were $20 and the total of the hourly rates of the men on the job came to $10. Then a man whose hourly rate was 60 cents would receive 6 per cent of the total or $1.20, a man at 50 cents, 5 per cent, and so on in a 100 per cent bonus plan. Should any man not have worked the full period, his share would be reduced pro rata and the undistributed amount divided among the others.

Group plans simplify accounting, paperwork, and inspection. They are at their best where the product flows through a series of operations—that is, where the work of each man depends on that of the man before him. A similar situation is met in automobile and similar assembly lines. The group plan is also applicable to the group small enough so that all its members are in continuous contact with one another. In this case, everyone knows when anyone shirks his share of the load. The group plan does not work well in very large groups, or in groups that are scattered and in which the various tasks are not logically part of a single performance.

A Possible Drawback

Use of the group plan does not remove the difficulty of rate cutting. Frequently a group will find ways of increasing its efficiency. It may find it possible to get along without some of its members, and request the management to transfer some workers or not to fill places made vacant by resignations. While the employer

may hesitate to disturb a group that has developed a high efficiency and team work, he runs the danger that, if his original estimates were far out of line, he may in the end find himself committed to a very high labor cost.

Presumably in order to avoid this difficulty the Edison General Electric Appliance Company[10] used the Rowan plan of payment for groups. The group plan offers more temptation to careless rate setting than do individual plans. It was extremely popular several years ago and has since been abandoned by some companies, in many cases undoubtedly because of an undiscriminating application to conditions to which it is not suitable.

[10]See "Group Incentives—a Study in Compensation Policies" by W. R. Tuttle in *Wage Payment Plans that Reduced Production Costs*, Hugo Diemer, McGraw-Hill Publishing Co.

CHAPTER SEVEN

Incentives for Executives

BASICALLY, the problem of payment is the same with executives as with other classes of workers. Conditions alter the problem substantially, however. In the first place, the higher ranks of general executive have a different outlook on wages than the man in the ranks. Where the latter desires security, the man in higher income levels and with a different perspective of management problems usually desires to share in the profits he creates. For this reason, payment to general executives is frequently in the form of a relatively low fixed salary. In some cases, as of reorganization or change of policies in which a new man undertakes to improve a company's position, he may be given an option at an agreed price, on a substantial block of stock, from whose appreciation he will profit if his work is successful.

Goals to Shoot At

For supervisors and operating executives in the lower salary ranges, the importance of security increases and the desire for participation in speculative profits recedes. Supervisors are frequently, as in the Bedeaux plan mentioned, given a bonus based on the percentage of attainment of standard by their crew. Such a plan was originally proposed by H. L. Gantt.

Where a company has a fully integrated production and expense budget, probably the most effective plan of payment of supervisors (and indeed the plan is applicable all the way up to the president) is the payment of the supervisor on the basis of a fixed salary plus a bonus that is a percentage of the amount by which the actual departmental costs are below the allowed or standard costs. Since the master budget for a department is subject to frequent revision with changing conditions, the adjustment of this bonus evidently requires fairness and discretion, and is likely to introduce a bargaining element into the situation. Where a man consistently beats the average records, one possibility is to impose an increased cost load on his department by raising his salary. This decreases his saving and bonus, but gives him new goals to shoot at.

All operating cost estimates are apt to contain a measure of speculative elements not fully under the control of the department head. Payments should therefore be subject to the rules already given for such cases; the employee should be protected by a minimum, relatively high or low according to the degree of control and the desire to share speculative factors. The problem of working out an effective supervisor's payment is to a considerable degree tied up with cost theory. For example, the development of master budgets taking into account the effect of volume fluctuations on costs has made bonus systems desirable that would have been impracticable before.

When Work Is Routine

The payment of routine indirect workers may follow much the same principles as that of other workers. Straight piece rate or bonus plans are suitable where the work is routine and capable of measurement and standardization. Many clerical tasks are essentially "position" tasks. For these tasks straight daywork may be both the simplest, least controversial and effective plan. Monthly wages may be supplemented in the case of such people as telephone operators, a receptionist, a bookkeeper responsible for a particular ledger, or the like, by non-production bonuses for regularity of attendance, for accuracy, or for other qualities. Or recognition may be given in non-financial ways, as by a longer vacation, preference in choice of vacation dates, etc.

Same Problem in Maintenance

When we come to indirect workers in the shop, as maintenance men, the basic problem still remains the same. Part of the work is "position" work, and the correct procedure is to lay out a schedule of duties, oiling, inspection, and the like, and from time to time to check to make sure that changes in demand do not imperceptibly but gradually unbalance the schedule.

Inspection of the work done, supervisory praise or reproof or instruction, or non-production bonuses such as one based inversely to percentage of time machines are down, may supplement the basic hourly rate. We should not forget the directive power of good and discriminating supervision. For tasks not of a strictly repetitive nature, the approval of the supervisor—and his translation of that approval into recognition in the giving of responsibilities, in promotion and layoffs and wage increases—is the basic and most important incentive as well as the most flexible one.

Must Be a Goal

Payment for suggestions, inventive work, and improvements should be considered in this discussion. In the case of staff men, research men, and the like employed specifically to investigate and develop such inventions, the custom is fairly clear. The company takes the risk and pays the man a fixed salary. Important creative work may be recognized by promotion, salary increases, bonuses, or other forms of recognition. It should be recognized that, so long as the employee feels that he is being fairly treated, work of this character to a very large extent carries its own strong stimulus of interest; the research man does not need to translate his progress hourly into terms of money in order to maintain his interest and output. In this work, as in all work, of course, there must be check-up, recognition, and, to the laggard, admonition; it is a well-nigh universal human tendency to slack off when there is no defined goal and no spur to attainment.

CHAPTER EIGHT

Non-Financial Incentives

IN 1927 a series of experiments were conducted at the Hawthorne plant of the Western Electric Company[11] which, while not claimed by those engaged in them as conclusive, provoke considerable thought. A group of four women operators, routine workers of the normal type, were made the subjects and participants in a series of experiments in the effect of various conditions, incentives, and so on, on output. A curious fact was noted—namely, that the output curve kept rising, month after month, regardless of the system of payment, the room conditions, or the other factors under test. I quote from Mr. Pennock's discussion of the conclusion that the investigators came to, a conclusion confirmed by comparison with otherwise similar operations performed in the production departments, and to the effect that the increase appears to have resulted, not from any specific change in physical or incentive conditions, but from a change in mental attitude on the part of the operators.

"Confirming this belief there are many items of evidence. A relationship of confidence and friendliness had been established with these girls to such an extent that practically no supervision is required. In the absence of any drive or urge whatsoever they can be depended on to do their best. They say they have no sensation of working faster now than under previous conditions, and that their greatly increased output has been accomplished without any conscious effort on their part. Comment after comment from the girls indicates that they have been relieved of the nervous tension under which they previously worked. They have ceased to regard the man in charge as a boss. Specific and individual studies were made which prove for these girls what you know about yourself—that you can work much more efficiently in a contented frame of mind than you can when your mind is in a turmoil of worry, fear or discontent."

Making due allowances for the difficulty of translating such results, secured under ideal experimental conditions, into a workable shop procedure with run-of-mine supervisors, there is still in this conclusion food for thought. A release of the positive drives is always more productive, as well as more frictionless, than the use of the negative drives of fear. We have already pointed out the negative correlation that exists between accurate performance standards and the need for elaborate incentive formulas. Perhaps a concentration on the education of supervisors, not only in the technique of their jobs but also in the technique of leadership and handling men, would be more productive than further development of formulas for payment.

Signs of Incompetence

The resort to threats, force, or fear in supervision is practically always a sign of incompetence, either on the supervisor's part or the part of those who have earlier formed the emotional pattern of the men with whom he deals. The reason for the extensive interest in direct incentive formulas (although there will always be a place for plans that connect performance with reward) may have been in part due to the failure of supervision. It is another corollary of the question of task standardization that the more dependable is the knowledge on the part of both parties of what task may properly be expected, the slighter becomes the need for force in securing its performance. The force motive never wholly recedes from supervision, but in good leadership it is lost sight of behind the more positive drives of interest, pleasure in responsibility and accomplishment, and loyalty.

Room for Research

All this sounds somewhat idealistic, but so did the idea of scientific management, standardization, and motion study a quarter-century ago. We may hope that the application of research methods may yield as great a release of human energies in the field of human relations as did scientific management in improving the structure and mechanics of organization.

Many of the non-financial incentives are familiar to all industrial men. Only a few need be mentioned, by way of illustration:

1. A man's pleasure in his task is proportioned to his competence in it. Better and more systematic teaching of the job is one effective means of increasing interest and quality. Motion study[12] is one of the promising approaches to teaching of routine tasks.

2. A man's interest in his task is somewhat proportional to his control of it and of the results. It is a mistake to give detailed orders which deprive the operator of initiative, when the same result could be secured, at no greater cost, by supplying a general background of knowledge which would enable the man to make his own decisions.

3. It is a mistake to keep the fear of discharge in the foreground, to keep people "on the anxious seat" continually, or to promote unlimited competitions in which the loser fears elimination. Although such tactics may galvanize into temporary action, the ultimate effect of fear is always inhibitive and repressive. Such tactics must sometimes be employed in special cases but should be minimized.

4. Recognition is one of the most valued of the non-financial incentives. While praise should not be too easily earned, it should be forthcoming whenever it is earned, and should be in the form most valuable to the recipient. Recognition may come in the selection for further responsibilities as well as in direct words.

Balanced Perspective

We are likely in the immediate future at least to see a greater emphasis on security by legislation as compared with the idea of competitive advancement. We are likely to see a general simplification and restriction in the variety of plans, with the emphasis probably on plans such as piece rate or composite piece rate or point systems that pay for measured productivity. We should see further progress in the measurement and correct analysis of factors of productivity and cost, the isolation of the mixed variables that have in the past so confused incentive payment. And it is to be hoped that we shall develop a more balanced perspective, a realization that incentive plans are an inadequate substitute for good supervision, and certainly not for good management.

[11] See *Research Studies in Employee Effectiveness and Industrial Relations*, reprint of talks before the Personnel Research Federation in 1929, by G. A. Pennock, M. L. Putnam, and Elton Mayo.

[12] See "How to Set Up a Program in Motion Economy" by Allan H. Mogensen, in *Factory's* Plant Operation Library for November, 1935.

Construction Modernization Maintenance

PLANT BUILDINGS

YOUR BUILDINGS AND YOUR PROFITS

• Recovery has begun. Every manufacturing plant is in the race for business. The share secured by any given plant will depend upon the extent to which that plant's products can be sold. Products can be sold only if they possess the right attributes of quality, utility, appearance, and price. All of these attributes are extensively affected by the buildings within which the products are made.

Under today's conditions it is not enough for industry to be using modern production equipment, modern power transmission and control equipment, and modern handling equipment; it must also use modern buildings. Unless it does, the greatest productivity from the manufacturing equipment cannot be secured.

All the factors that influence product cost must tie together to be of maximum help in today's efforts upon the part of the industrial plant to secure its proportionate share of markets that are becoming harder and harder to dominate.

INFLUENCE ON PRODUCT COST

Plant buildings must be as modern as production equipment. They must be as well maintained. Their type of construction is a strong influence in product cost. The materials used in their construction can aid or retard plant operation. Plant service equipment has much effect upon the efficiency with which the personnel does its work.

Buildings that are not designed and constructed to fit the work that must be done within them cause wastes in many directions. Floors may be floors, but their kind and condition affect handling, spoilage, and safety. Defective roofs may cause damage to products and equipment. Lighting that is inadequate causes spoilage and poor quality. Lack of conditioned air in many instances is responsible for an inferior product or unjustifiable waste in manufacture. Employees who work in poorly equipped buildings are almost certain to produce to low standards and contribute to unduly high turnover.

Buildings that are not properly maintained are a source of unnecessary expenditure and destruction of capital assets. There can be no valid excuse for gross neglect. Not only will complete and timely maintenance favorably affect the efficiency of production, and the health and morale of workers; it will avoid penalties in actual cash outlay that industry cannot afford to pay.

FOLLOW THROUGH

Factory's advice is: Look to your buildings. Build if necessary and build right. Rehabilitate when new building is not called for and, in doing so, modernize. In all cases, establish a program for preventive maintenance, and follow it through.

To help you heed this advice, there are presented in this Special Section the "new building" story of four modern plants; the "maintenance" story of the Clearing Industrial District, of Chicago; and essential reference data concerning building materials and building upkeep.

The Special Section is an "experience" presentation. It may best be summarized as the *recommended practices* of the several plants concerned, who have endorsed them to the extent that they have based expenditures upon them.

Sheets are delivered to the stockroom by electric truck, and to printing, cutting, and other machines on the second floor via the ramp

In 3 New Plants . . . . BUILDING That

I. Chicago Carton Company

• When the Chicago Carton Company committed itself to a new plant it did so with very definite objectives. Chief among them were quality control of product, low handling costs, good light, worker comfort.

Note that all of these objectives, when attained, combine to give industry's major objective—low product cost. Here is how the objectives were reached:

QUALITY CONTROL OF PRODUCT

Paper carton manufacture, as carried out in this plant, consists of changing rolls of paper stock into flat sheets, printed, scored, and cut so that they will fold into containers.

Paper is sensitive to atmospheric conditions. Its size changes with variations in temperature and humidity; yet if progressive colors are to register the paper must be the same size at each printing. Ink pigments dry slowly in hot, humid weather. Rollers soften, reduce quality. To overcome these impediments to quality the air is conditioned. Temperature and humidity are regulated in all seasons by means of automatic controls. Instruments record the conditions obtained.

Dust is bad for printing processes. If it settles on a freshly printed surface, it mars appearance. It may damage type and plates. So the saw-tooth roof, of poured concrete slabs, is constructed without steel trusses; thus the surfaces likely to collect dust are minimized, are easily cleaned. Moreover, they were the more easily insulated, a procedure that was followed in the interest of efficient heating and air conditioning.

This matter of air conditioning for quality control influenced building construction in other directions. The saw-tooth skylights are double glazed. Storage space for goods in process and for roll stocks are closed to the outside world—for all the paper must have the same size throughout manufacture. The railroad track is inclosed, so that air conditioning begins the minute the spotting engine has pulled away and the doors have been closed. Track capacity of 10 cars makes frequent opening of main doors unnecessary. Doors are insulated.

Depending upon the design of the finished product, paper may have to be treated with paraffin, silicate, tar, or glue. Fumes that accompany any of these applications are disposed of by means of exhaust hoods and fans.

LOW HANDLING COSTS

Product costs are directly related to handling costs. In this plant there is no need for gravity flow, hence multi-story construction was not necessary. This fact, together with the availability of land at moderate price, determined the two-story construction adopted. Two-story construction presented the opportunity to use a ramp and electric trucks. It also permitted wide spacing of columns in the second floor. They are on 48-ft. centers, and interfere not at all with truck movement.

By the arrangement adopted, the heavy rolls of paper stock are taken into the first floor of the plant in box-cars on a depressed track that permits floor level unloading. The rolls are handled by a 7½-ton crane in the roll room, in which location they are turned into the needed combinations of thickness and are cut into sheets.

Sheets are delivered to the stockroom on the same floor, and to the printing, cutting, and other machines on the second floor by means of the electric trucks via the ramp. Finished cartons are taken down the ramp for loading and shipment.

Skids are used, of course—for transportation and for storing. Their initial cost is high, but they prevent unnecessary handling between stopping points. A built-in platform scale permits weighing stock while it is on skid and truck. Paper stock, in storage, is all double-tiered by lift trucks.

To limit the extent of influence of unconditioned air admitted by the opening of outside doors, the plant is divided into large rooms. Connecting doors might be expected to cause some delay in moving materials. They do not, however, because they are air-operated by means of control valves placed in the floor. The truck runs over a floor plate which operates the valve to open the door. Plates are so positioned that door opening synchronizes with truck speed and no time is lost. The closing valve, on the other side of the door, also is operated by floor plate control. For the pedestrian, pull cords are provided; he can walk on the floor plate without affecting the door-operating mechanism.

Beside paper stocks, there are other items that must be handled—printing and cutting forms, plates, inks, supplies. The electric trucks serve here also. Over a period of time this part of the handling job amounts to something. There is a single steel filing rack that holds 50 tons of electrotypes. For each run forms or plates must be transported to and from storage, composing room, or die room to presses and back. The job may be one for a single-

FEATURES

Influence Product Costs

color flat-bed press or a multi-color rotary, or for a press somewhere in between—but transportation must be had just the same.

GOOD LIGHT

Good printing can be done in artificial light. Good printing can be done more easily—with less nervous strain on the part of the worker—in good natural light. In the carton plant daylight pours in on all sides of the building and through the skylight. For most of the day during much of the year natural light is depended upon. Ceilings and upper walls are painted white, and all doors and lower walls are painted bluish-gray.

On dark days, and during the night shifts, general lighting from RLM domes is available, and localized lighting is provided at the machines. Intensities in accordance with accepted practice prevail. Skimping on lighting offers no great opportunity for savings in the printing business. Too many details have to be watched with meticulous care—color, register, impression, offset. Moreover, the lighting load is not heavy in proportion to the total electric load, and drastic economies would not effect worthwhile savings, in spite of the fact that all current is purchased.

WORKER COMFORT

Somehow or other, worker comfort affects the quality of printing. Barring the occasional wash-up of press and rollers, printing is clean work that turns out a product which must be clean. Butter, cakes, pies, for example, won't sell in dirty dress. It is only natural that the printing-plant employee wants the opportunity to keep himself as well as his work as clean as possible, and to spend his working time in comfort.

The Chicago Carton plant allows him to do so. Steel lockers are provided for his clothes. Shower baths are available. Wash fountains are standard equipment. So are drinking fountains. Suspended unit heaters and wall radiators, served by the Company's own boilers, keep him warm. Conditioned air helps him as well as his product. Fans are available for air circulation. He can telephone from a pay booth in the factory if need be. Complete fire-fighting equipment—sprinklers, hose, extinguishers—makes for his safety. Three hundred of him can at one time feed in the plant cafeteria.

Suppose the employee works in the office. He finds that he can neither hear nor feel the plant—the office is insulated against noise and vibration, and is equipped with a sound-absorbing ceiling. He walks on waxed rubber tile. The air is warmed (or cooled) and humidified. He has a flood of natural light the full width of the office, that he can temper by means of Venetian blinds, or he is served by indirect artificial light from wall troughs. In short, he finds that he can give his best to his work, because he need waste no time in counteracting irritations and inconveniences that would make him uncomfortable.

DESIGN FEATURES

So much for the four principal objectives aimed at holding down product costs. A few words about other building features. This plant that cost approximately three-quarters of a million exclusive of equipment is something like 520 feet wide, 275 feet deep. It is of flatslab type, reinforced concrete construction, with exterior of face brick with Bedford limestone trim. Hollow tile is used extensively in partitions. Floors are of concrete.

The floor of the print shop is de-

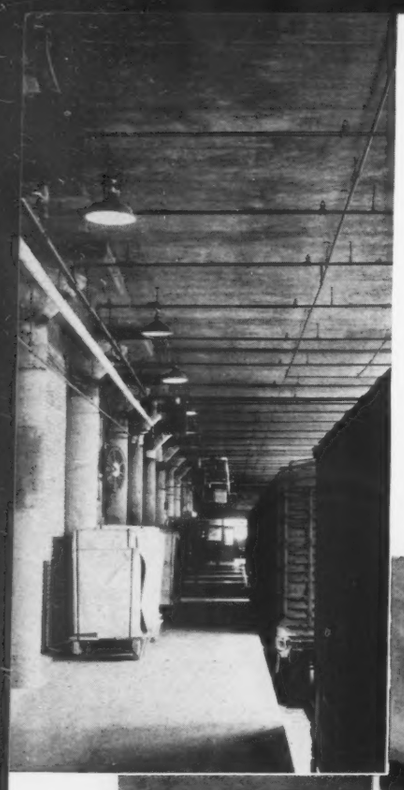
Plant cafeteria serves good food to 300 employees at one sitting

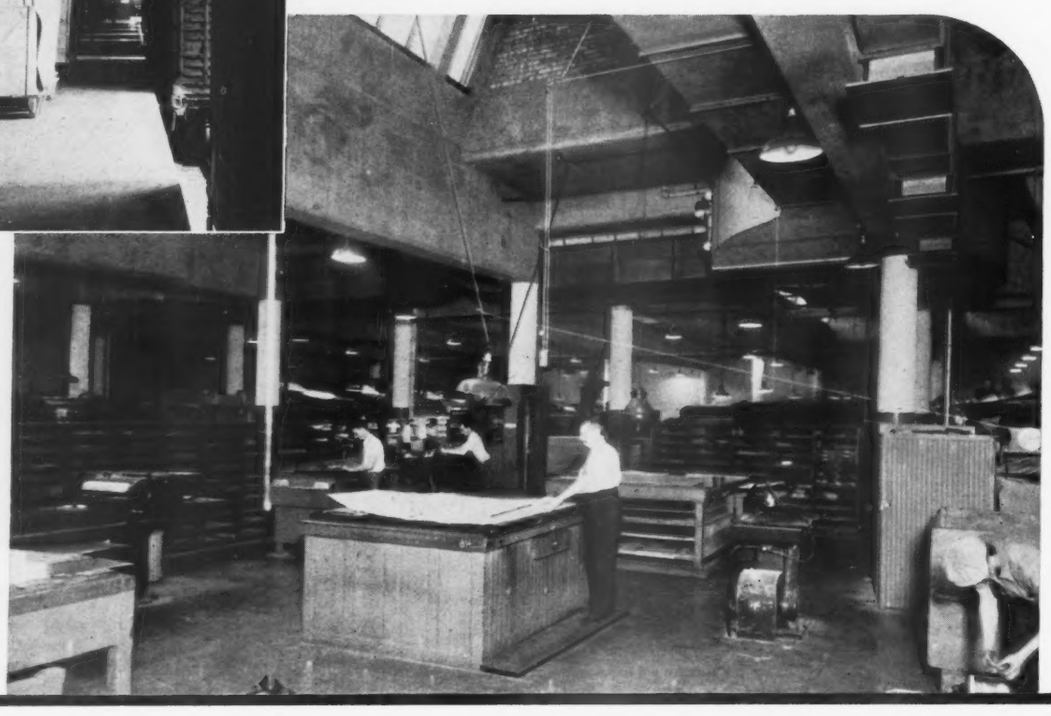
With no need for gravity flow, with land available at moderate price, two-story construction best fitted Chicago Carton Company's production requirements

signed to sustain extra heavy live loads. Wooden bases were installed in the concrete as foundations for the presses. There is almost a complete absence of vibration. All power conduit is carried in the floor; leads are run up to the individually driven machines. Steel windows are used, which increases resistance to fire. So do steel lockers, steel storeroom partitions, and steel shelving in composing room and plate storage departments.

A. Epstein, structural engineer, prepared the plans and specifications. The general construction contract was executed by the Poirot Construction Company.

The building has an attractive appearance as well as a high utility value. It is doing what every industrial building should do—furnishing opportunity for full value to be gotten from the modern equipment that it houses and the people who work within it.





Unit heaters maintain comfortable working conditions on the unloading platform

Conditioned air, automatically controlled, safeguards printing processes, insures quality product. View of composing room at Chicago Carton Company

III. National Can Company

• When increased demand for its products made it necessary for the National Can Co., Inc., to build an extensive addition to its Maspeth, N. Y., plant, there was available plenty of experience in the manufacture of cans to show what features of design and construction are desirable or necessary. This company operates plants for making various kinds of cans in Baltimore, Chicago, Detroit, New Orleans, Boston, Hamilton, Ohio, Brooklyn and Maspeth, New York.

Cans must be perfect; leaks or other defects cannot be tolerated. Also, they must be low in cost, because the manufacture of cans is a highly competitive business. All of this boils down to the fact that equipment, housing and all facilities and services must be top-notch in every respect in order to take full advantage of every aid to the production of a better product at lower cost.

Requirements for space dictated dimensions of 280x200 ft. for the new building, which was designed by Brown & Matthews, Inc., of New York. With a sufficient amount of comparatively low-cost land available, there was no point in piling one story on top of another; nor are the processes or the layout such that gravity flow would be an important advantage. Therefore, it was decided to build a two-story structure. At the same time, consideration of requirements likely to arise in the future indicated the wisdom of providing for easy enlargement, and the foundations and steel work were designed to support a four-story structure. When the time comes that more space is needed, providing it will be simply a matter of jacking the roof up and building one or two more floors under it.

National Can likes to have its buildings good-looking as well as perfectly adapted to the needs; therefore, the outer walls of the new plant are faced with a fine, light-colored face-brick. The foundation is poured concrete.

Presses and other machinery used in making cans are heavy; much of the equipment operates at fairly high speed. This means that floors must be designed for heavy loads and the entire structure must be built solidly to withstand vibration. Interior walls separating some of the departments are all of brick. They are solid and strong, fireproof, cost little to maintain.

CONSIDERABLE TRUCKING

Floors in this new building are in most places subjected to hard usage. Heavy machines will be rolled or dragged over them. Considerable trucking is necessary. Concrete, treated with a hardener, is used for floors throughout the building, except in the lithographing department.

In this department it is essential to have a somewhat resilient floor and one

that is dustless. The reason for this requirement lies largely in the fact that lithographing the thin sheet metal used in making cans is in some respects practically the same as printing on paper. The metal sheets are passed one or more times through presses where the color and design are applied. From the presses the sheets pass onto a conveyor which takes them through a drying oven. The final result must be a perfectly smooth, glossy finish that is free from dust specks and discoloration.

It would be very difficult, perhaps impossible, to produce the quality of work desired over a floor that is given to dusting. Therefore, in this department the floor is composed of impregnated wood blocks set on end. Such a floor is dustless, cannot be chipped or damaged by falling objects, and is practically jar- and sound-proof.

An extensive system of large ducts and fans draws all fumes and smoke from the drying ovens, thus insuring a cooler, more comfortable workplace for the operators, as well as a better product at lower cost.

TEMPERATURE CONTROL

Close temperature control is essential in the lithographing department and was considered desirable throughout all of the other departments. It is provided by thermostat controlled unit heaters, of which about 60 are in use. Heating requirements in this plant vary rather widely. For example, a fairly low temperature is satisfactory for some of the storage areas in which employees are not continually at work. In the production department, on the other hand, worker comfort and efficiency demand a temperature of 65 to 70 deg. F. With unit heaters controlled by thermostats, it is easy to keep the temperature in any area at the desired level.

Various considerations, including the practical certainty that the building will be enlarged by adding additional stories in the future, led to the choice of a steel deck roof. It is strong, easy to erect, cannot crack or flake off, and requires no maintenance other than an occasional coat of paint. It is covered on the outside with 2-in. insulation to reduce loss of heat and prevent condensation of moisture, topped off by a five-ply layer of impregnated asbestos rag felt covered with slag.

To provide as much natural light as possible for the second floor, a skylight was run down the center of the building. On both floors the window area is practically the maximum possible amount. On bright days natural daylight is adequate in most places.

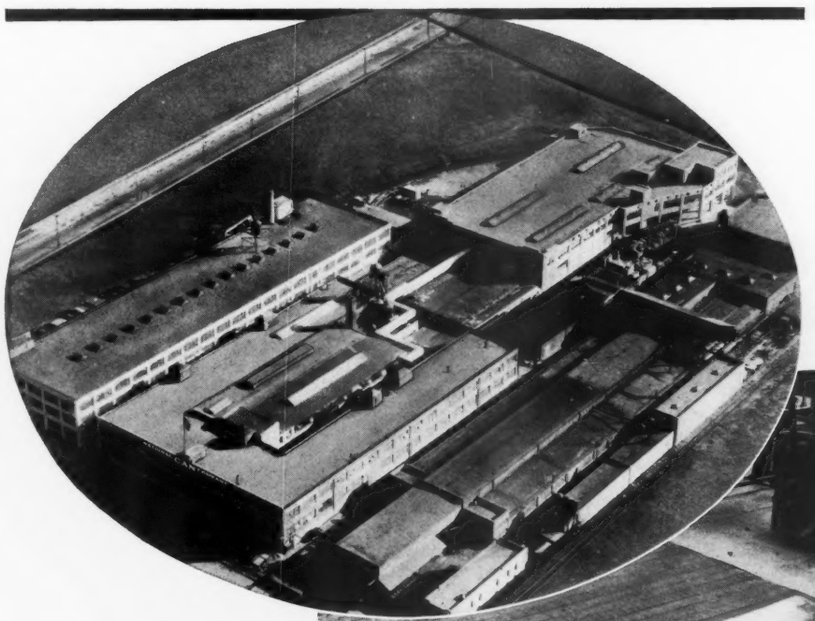
LIGHTING FITS JOBS

Artificial illumination is provided by 200-watt lamps in R.L.M. dome reflectors. Intensity of illumination is fitted to the varying requirements of different production departments.

Handling of materials in a can factory presents problems that have to be carefully thought out. The chief raw material, thin, tinned iron, is heavy and compact. It comes in the form of sheets which vary in their dimensions according to the type and size of cans to be produced, but as an average value measure about 24x36 in. A box of sheets weighs a ton, and will be from 12 to 20 in. high.

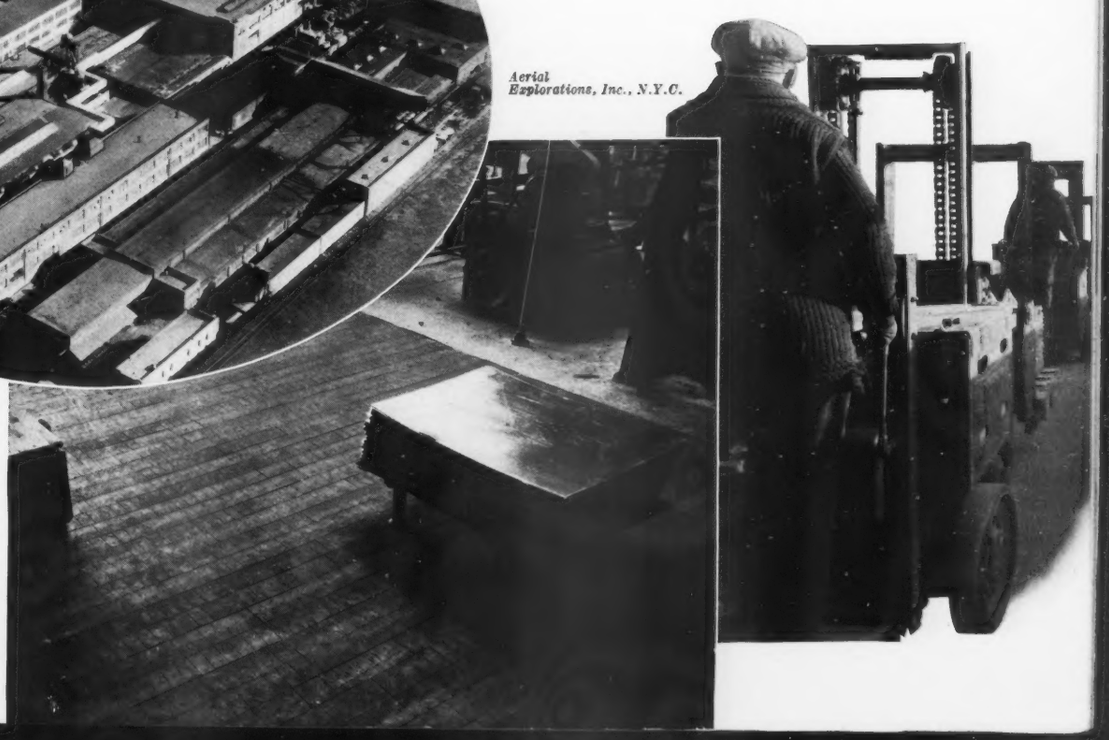
Finished cans, on the other hand, are

On bright days, natural daylighting suffices in most parts of the second floor. Here, a slice of skylight



Aerial photograph of National Can Company's plant on Long Island . . . For a resilient floor and one that is not given to dusting, impregnated wood blocks set on end have been chosen

Aerial Explorations, Inc., N.Y.C.



Industrial trucks have no trouble "making the grade" as they move raw materials via ramp from storage on the first floor to production on the second

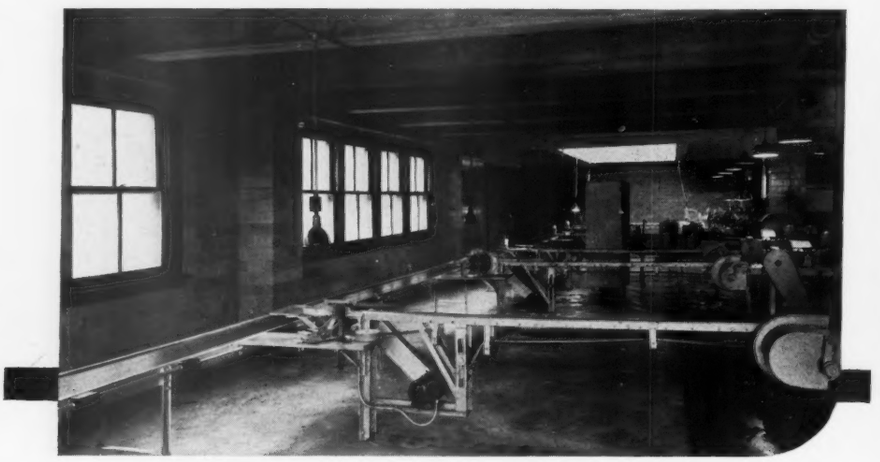
very bulky compared to their weight. These conditions are met by using storage battery trucks for handling the boxes of iron, while much of the finished product is delivered by gravity from the production department on the second floor to the storage areas on the first.

A large, covered shipping platform was formed at one corner of the building by setting the walls of the first floor back the desired distance. As they approach this corner of the building, the railroad siding branches out into a Y, so that one end and one side of the platform are each served from a separate truck.

BETWEEN FLOORS, A RAMP

All incoming material is received on the shipping platform, which is car-door high, and transported to the storage spaces immediately adjacent, inside the building. They are then carried by electric truck to the production department on the second floor, over a long ramp 10 ft. wide, that connects the first and second floors.

Fire-doors at the ends of the ramp and between departments are fitted with a heavy curved steel spring or bumper placed at the proper height to engage the platform of the truck. To open a door, the operator merely drives the truck at reduced speed against this bumper. After the truck has passed through into the adjoining department, the door is immediately closed behind it by a spring-operated device.



Hot water and steam, used copiously in sterilizing milk processing equipment, impose rigid restrictions on choice of building materials. View of Sealcone department, with tiled walls, copper-clad window frames, cement ceiling

Sheffield Farms Company

BUILDING a new plant is one problem. Revamping an existing structure to fit present needs is quite another. Adding substantially to an old plant, and at the same time modernizing existing facilities, partakes of the nature of both these problems and presents many of the more difficult features of each. How such a job was handled in one notable instance is well illustrated out of the experience of the Sheffield Farms Company, Inc., in its 125th Street (New York City) plant.

This concern, a large distributor of milk and other dairy products, operates a number of plants in the metropolitan area. The plant at 125th Street was housed in a four-story steel, concrete, and terra cotta structure measuring 132 by 150 ft. Designed and built in accordance with the best practice of 26 years ago, it had been carefully maintained, yet was definitely outmoded by advances that had been made in building materials since its erection.

Two years ago a major change in processing set-up made it necessary to increase floor space. A 52-ft. addition was therefore planned and built, and at the same time radical changes were made in the old structure in order to bring it strictly up to date. In making these changes, incidentally, the problem was further complicated by the fact that there were two large bottle washers on the first floor that could not be moved. Hence all other processing operations had to be built around this equipment.

HARD TO TELL OLD FROM NEW

Result is in effect a new building in which, as you go from department to department, it is mostly impossible for even an inquisitive visitor to tell whether he is in the older or the newer section. So far as external appearance goes, the new structure exactly matches the old building which, in order to complete the illusion, was refaced with terra cotta, the new terra cotta being laid right over and anchored into the old.

Reasons for making some of the changes will perhaps be clearer if the character of the processes is understood.

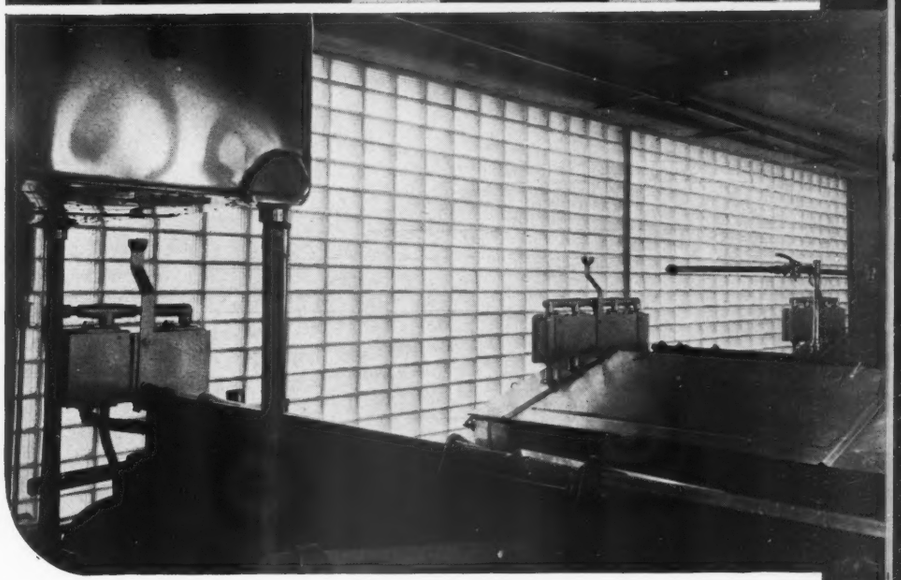
Briefly, processing operations consist of taking raw milk and preparing it for consumption. Raw milk is pumped immediately on arrival into one of six 1,500-gal. tanks located in a penthouse that is specially constructed so that no load is imposed on the roof but is carried by the building columns. From these tanks the milk flows by gravity to the various processing departments. At the end of each run, all tanks, pasteurizers, coolers, even pipe lines, must be thoroughly cleansed and sterilized. *Everything* is taken apart *every* day.

This daily job of cleaning and sterilizing means copious use of hot water and steam. They in turn mean wet walls and floors and condensation on the ceilings. Such severe operating conditions imposed severe restrictions on the choice of building materials.

As originally constructed, all walls and ceilings in the old building were plastered and painted white. But no paint will stand up long under the conditions so briefly referred to. Wherever they exist, therefore, whether in the old or new building, buff-colored Brictile has been used on the walls.

Tiled walls look better, for one thing. Also, they require no maintenance. There is no paint to flake off. There are no cracks for dirt to lodge in. They can be scrubbed and hosed down without harm as often as necessary.

Floors were originally concrete



More production, more men; more men, more shower baths. These are marble . . . Glass bricks used in walls of a light court in the center of the old building give more light—and were actually cheaper than replacing old windows

throughout. Red packing house tile has now replaced it in all processing departments, except where milk cans and cases are handled. Main reason for choosing this tile is that under the operating conditions cited it wears better. Certainly it is more easily cleaned, and furthermore it absorbs only 2 to 3 per cent of moisture.

Tile, on the other hand, is more easily damaged by a hard blow. For that reason concrete is still used where cans and cases must be handled. At points of greatest wear, as in certain locations on the loading platform, cast-iron grids are set into the concrete.

CONCRETE PLASTER CEILINGS

Ceilings in the new building are all concrete which is unaffected by the unavoidable condensation. They conform in appearance to the plastered ceilings of the old structure, and by using pressed wood in the forms, the beams were coved and bullnosed in order to eliminate any sharp corners where dirt might lodge and stick. Some of the old plastered ceilings, for that matter, have been Gun-ited and are now hard, permanent concrete like the new ones.

Roof is of the slag type. All galvanized iron, formerly used for flashings, skylights, etc., has been replaced by copper. The old elevator penthouse, which was a continuous source of leaks, has been covered by corrugated steel with a protective coating that definitely ends that particular type of annoyance.

Window sash and frames throughout both old and new sections of the plant are copper-clad. For one thing, they are fire-resistant. For another, they resist corrosion and will naturally stand up far better than wooden ones, and should require little if any maintenance.

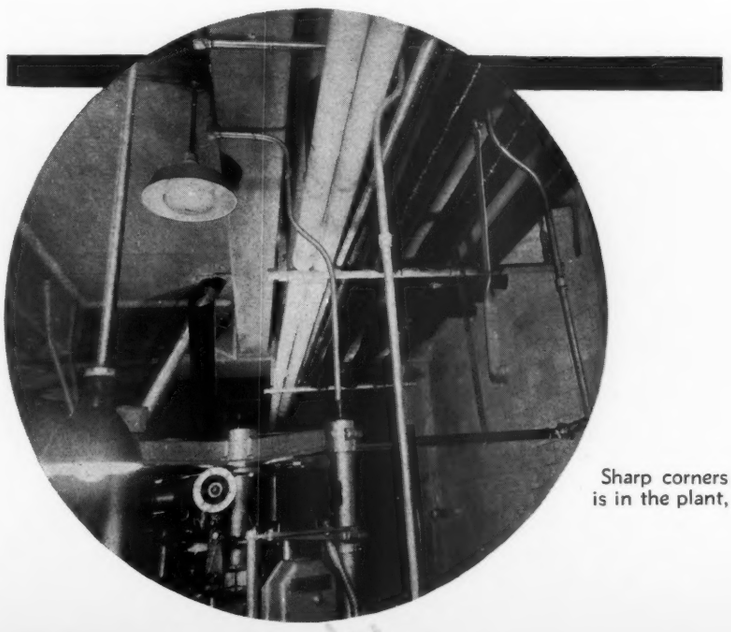
Especially interesting is the use of glass blocks in the walls of a light court that runs up through the center of the old building. These sections of glass wall have been used in such departments as the cream and milk pasteurizing rooms on the third floor, and again in the cooling room on the second.

There are good reasons for choosing glass blocks. First, they let in more light than windows and they look good. Second, much of the processing equipment is very close to the windows, and all the hot water and steam used for cleaning and sterlizing purposes has no effect on the glass blocks other than to keep them perfectly clean, whereas windows do not bear up quite so well under that sort of treatment. A third and not unimportant point is that it actually cost less to put in glass block walls than it would have cost to replace the old, worn-out windows.

BUILT-IN HANDLING

Handling equipment in a plant like this is all of the permanently built-in type and thus deserves a word in this brief description of building features that help to keep operating costs low. For instance, a new 20,000-lb. elevator with a 10 by 16 ft. car and a speed of 75 ft. per min. serves all floors. It is self-leveling and pushbutton controlled.

One of the major changes consisted of setting up a Sealcone department on the fourth floor where milk is packaged in paper containers. Here rubber belts convey filled packages to the packers who place filled cases on



Sharp corners are hard to keep clean. So not one is in the plant, not even where beam and ceiling meet

a wide rubber belt conveyor that takes them down the room to a spiral chute. This chute goes all the way down to a cooling room on the first floor.

Another important piece of handling equipment is a hoist that automatically delivers 120-lb. cans of cream to any one of three floors. Interestingly enough, it was adapted from an automatic elevator used to handle papers in a large insurance company. Other items include chain conveyors that move cases of empty bottles to the washers, a different type to move clean bottles to the filling machines. A bucket conveyor takes Pak-ice from the basement where it is made to the bins where it is stored prior to use. Crushed ice from other storage bins is blown through a 4-in. rubber pipe right into trucks.

Many other noteworthy changes have been made—for instance, the Sealcone department already mentioned has been installed on the fourth floor; the balance of that floor is given over to storerooms for parts, paper stock, paraffin, hoods, caps. On the third floor are the pasteurizing rooms for cream and milk, a butterfat laboratory, a sour cream room, a self-contained unit where a chocolate drink is made and bottled, a buttermilk room with six large tanks, a can washer and sterilizer.

WHERE ALL MAY SEE

Down one floor—on the second—we find the bacteriological laboratory, a cooling room, bottle washing and filling equipment for chocolate drink and sour cream, an ammonia compressor and pumps that circulate ice water, an ice making tank, offices, etc. And on the first floor are the loading platforms and bottle washers aforementioned. Incidentally, the space directly in front of the washers used to be a receiving platform. Now it has been transformed into a department where milk is bottled, capped, and sealed. Floor is tiled; walls are handsomely tiled in a greenish-gray shade; even the ceiling is tiled in a darker green. The entire operation is visible through plate glass windows from the street, where passers-by may stop and see a small part of the reason why they have to pay such-and-such a price for the morning's milk.

Plans are now under way for a visitors' reception room, from which regular tours of the plant will be conducted. It is on the third floor, and visitors will approach it through a lobby that has been enlarged to twice its original size and is tiled in the modern manner. May not the company reasonably expect this completely modern plant to be one of its very best salesmen?

Sound-absorbing ceilings permit calm concentration, allow partitions to stop short of the ceiling for good circulation of air, add to the distribution of both natural and artificial lighting

Sheffield at 125th Street, New York City. Architecturally attractive, with high utility value

BUILDING FEATURES

THAT MAKE BETTER WORKERS

Harris Calorific Company

THE CONSTRUCTION of a new plant always involves some planning. When, especially, the new plant is not to be justified solely on the basis of its ability to lower product costs—or to accomplish some obvious economy—the degree of that planning must be greater than ever to realize to the fullest the host of intangible—as well as tangible—benefits to be obtained from the newly created environment.

And, infrequently, but all the more inspiring when found, there are those owners and operators who realize that a third or more of their lives—a half of their waking hours—is spent in their plants, and that "something ought to be done" about making those surroundings more attractive, more of a help, if you please, in performing their work.

The management of The Harris Calorific Company, makers of gas welding and cutting apparatus, in its new Cleveland plant *has* most emphatically done something about it.

Conceive of a plant situated atop a hill overlooking both an inland sea and a metropolitan city; a plant surrounded by stately elms; grounds terraced with rock gardens, rustic steps, shrubs—the whole landscaped to blend in with an adjoining public park and boulevard. That such surroundings in upbuilding employee morale cannot but have a salutary influence upon manufacturing efficiencies and product cost is a foregone conclusion.

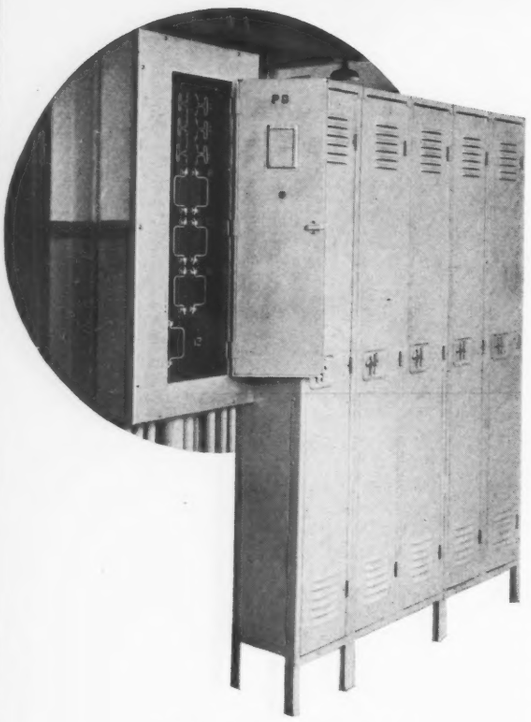
BUILT LAST YEAR

The single story, attractive red brick building, begun in late June, and occupied early in November, demonstrates what careful, skillful planning and painstaking attention to detail can really accomplish. Gillmore-Carmichael-Olson, Cleveland contractors, handled the construction. The architect was Ernest McGeorge, and Walter Harrison Smith directed the interior decoration.

Most obvious, perhaps, is the absence of overhead equipment. Pipes which distribute high and low pressure gases, air, and water, have all been concealed —to emerge from the factory floor at exactly those points where the services are wanted. Copper tubing, running inconspicuously up the steel building columns and across the girders, carries air at 2,000 lb. pressure to assembly and inspection benches. All steam lines, the only exposed piping in the plant, have welded connections, use welded drawn tube fittings to reduce friction losses to a minimum when carrying around bends.

Ingeniously constructed groups of assembly benches, each with individual gas, air, and electric services, the first two identified by colored valve handles, line the center aisle of the working area where they are *directly beneath* combination high-intensity mercury vapor and Mazda lamps. Ventilating fans, incorporated as a part of the

Inside the plant—service pipes and conduits in floor; unit heaters; rectangular ducts exhausting through sash openings in monitor; walls and ceilings white, concrete dull red



Power and light conduits are buried beneath the concrete floor. Steel lockers, painted gray, are grouped by departments

spray booths, remove the fumes from these sources, inconspicuously yet positively. They are supplemented by centrally located exhaust blower units which collect the dust from a row of buffing wheels and the gases from torch and testing benches and acid dips.

Machines are all individually driven, including some, such as shapers, lathes, and drill presses, which had to be revamped to get their motors *within* their bases. Likewise, the conduits which bring light and power circuits to these machines have been buried in the concrete floor.

The factory working area was made a single level to hold to a minimum the amount of travel between departments. The same idea has prevailed in the location of spray booths, buffing wheels, and inspection benches which have been so placed in relation to the flow of finished parts as to minimize lost motion. On the same principle, storage shelves and bins, outfitted with standardized steel trays that hold a predetermined number of parts, fit into portable hand trucks, and slide into place beneath work benches, have been strategically located to receive—and to discharge—the hundreds upon hundreds of small fittings that go into the Harris products.

While engineering and drafting rooms occupy a corner of the factory area, the production control office is, by contrast, located at the head of the center aisle—from which vantage point the activities of all the departments can be readily observed and guided.

AN OUTSTANDING LIGHTING JOB

The lighting installation, in particular, is outstanding. With as close tolerances as must be observed in the manufacture and assembly of valves and fittings, the best possible illumination, both natural and artificial, is required. The machining and finishing operations, as well as inspection are exacting performances. Consequently, the factory walls, of high-grade, smooth texture brick on the outside, and tile blocks inside, have been painted white, as have the ceilings.

By way of contrast, and to inculcate —psychologically—good housekeeping habits, the concrete floor has been finished with a hardener which presents in its dull red color a very real incentive to neatness. To contribute further to the cheerful appearance of the factory, light gray—rather than darker colored—steel partitions with glass upper panels have been used for the supervisory offices and storage bays. The steel shelves and bins have been similarly finished in light gray and add to the sense of orderliness.

A soft, well-diffused daylight is admitted through steel sash. This natural lighting can, as circumstances dictate, be supplemented by illumination from the combination high-intensity mercury vapor and Mazda units over the center of the working area and by more localized lighting from double rows of incandescent lamps in RLM reflectors mounted in the bays of the wings.

Steel lockers, likewise painted light gray, are arranged in groups of four and five at strategic points about the factory floor to avoid the confusion and congestion of a central locker room. A balcony washroom, with terrazzo floor, and central wash fountain, has been built into the monitor roof; is well-removed from the working area of the plant.

Warmed in winter with heat from thermostatically-controlled unit heaters, which are supplied with steam from a stoker-fired boiler in the basement, the building will be cooled and ventilated in warmer weather through mechanically operated monitor roof windows.

Dictated by considerations of safety as well as a desire to keep the outside of the plant as neat as the inside, the power and light transformers have been put in an underground vault in the yard. For much the same reasons a separate building, 25x17 ft., with extra heavy walls on property line and side facing the plant, and equipped according to specifications of The Underwriters Laboratories and Factory Mutuals with explosion-type window sash and roof, has been erected away from the main building to house the company's own automatic acetylene gas generator and oxygen manifold.

PERCHED ON A HILLSIDE

The location of the plant is further evidence, if any is needed, of the thorough planning which preceded construction. Perched on a hillside overlooking Bulkley Boulevard, the main thoroughfare from Cleveland's west side, and five minutes removed from the downtown Public Square, the front of the plant has two levels which permit an effective separation of office and factory entrances. Trucks coming from a trunk highway only a block distant can enter the building directly over a slag-macadam paved yard and through

either of two roll-up steel doors. Loading, or unloading, can be carried on inside the factory immediately adjacent to either end of the storage area. A heavy-duty shipping room scale, with direct reading illuminated dial, eliminating handling of weights, is located between these entrances, and available to operations on either side.

Access to the offices is, in effect, on the front street level, through an attractive two-story high, bronze doorway, set at a 45-degree angle across the corner of the building to face Lake Erie. A winding stair with triple brass hand rails leads from a small entrance lobby to another above where approximately 2,200 sq.ft. have been given over to the general and private offices.

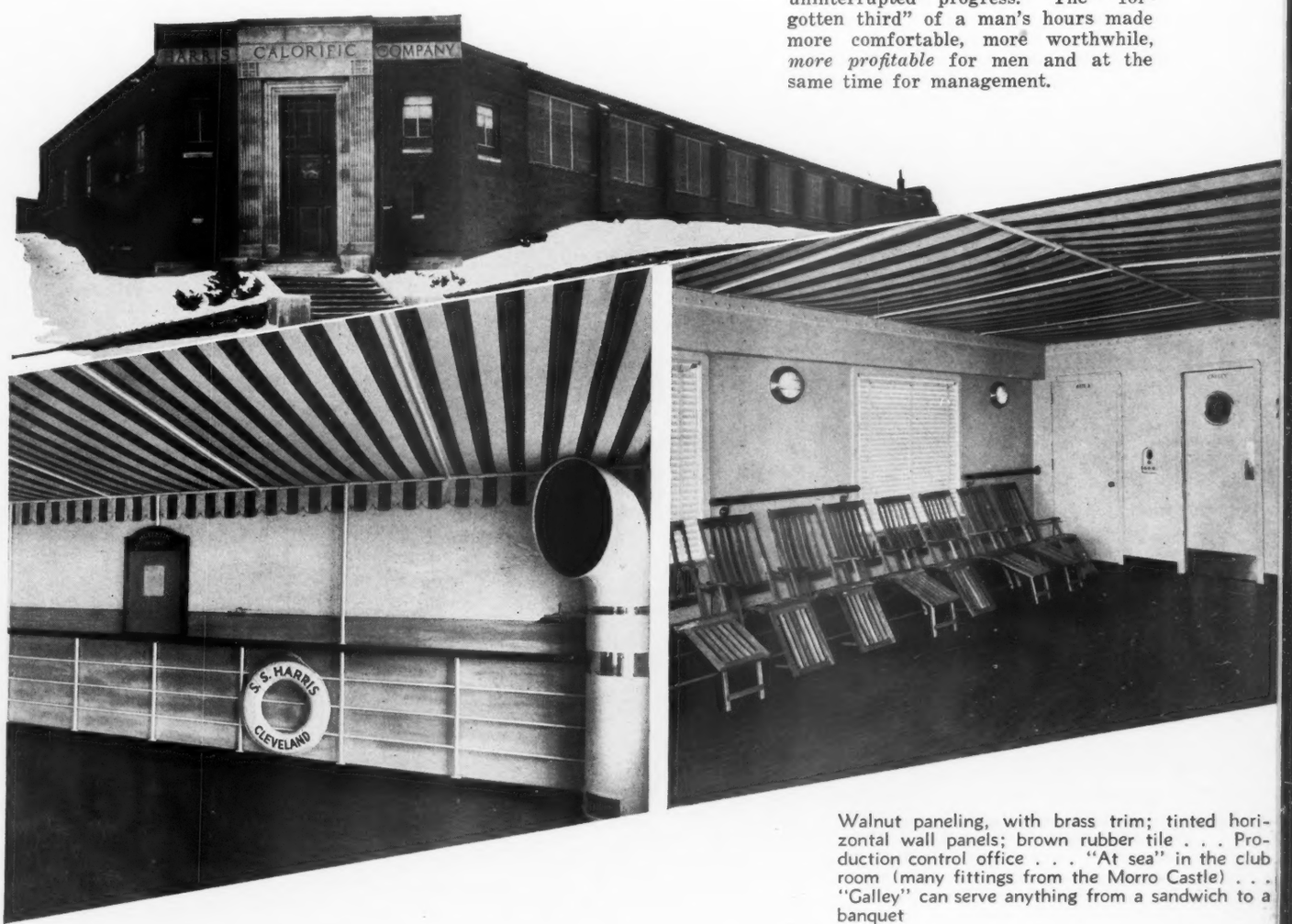
Steel casement windows flood the offices with daylight. Overhead, the latest in indirect lighting units has been provided for additional illumination. Supplemental localized lighting is available at each desk; it is supplied by individual study-type lamps mounted on swinging, telescoping arms which permit the units to be moved at will anywhere over the working area. A wall of tile between offices and factory shuts out the noise of the machinery. A mastic tile floor underfoot helps deaden noises within the offices themselves. Inlaid blocks of rubber tile in the private offices carry out the same idea there.

Nowhere, however, has the attention to careful planning borne more dramatic fruit than in the construction, on steel girders carried over the general offices, and through the forward section of the monitor roof, of a club room or entertainment deck. When, on the fateful night of September 8, 1934, the Ward Line "S.S. Morro Castle" caught fire and was beached on the New Jersey coast, the plans for the new plant of The Harris Calorific Company had not even been committed to paper. Inspired, however, by the fact that it was newly developed Harris cutting equipment, utilizing ordinary city gas in place of acetylene, which was used in the successful cutting up of the immense steel hull of the ill-fated liner, the motif adopted for this club room very strikingly duplicates the furnishings and equipment to be found on the lounging deck of an ocean-going passenger vessel.

GRIM MORRO CASTLE

One wall is covered by an ocean mural, painted by Kalmon Kubiyni. It depicts the entrance to Havana Harbor where ancient Morro Castle, grim, formidable fortress of stone, stands sentinel before incoming vessels. Along the wall opposite is a row of deck chairs. Overhead, a red and white striped awning, supported on metal stringers, contributes "atmosphere." Doors appropriately labeled in nautical terms, Suite A, Galley, Bath Steward, are located at one end of the "deck." At the other are windows of clear glass and French doors, through which access is given to an outside "promenade," surfaced with quarry tile, and—in a strategic elevated position—a ship's bridge. Here, salvaged from the wreck, has been appropriately mounted the wheel from the Morro Castle, while to right and left hang the green and red regulation running lights.

Thus, in an overall area of 240x100 ft., have been combined model factory, office, and entertainment facilities. At the front a high-speed passenger thoroughfare a few minutes from the heart of the great city; at the rear a trunk highway with direct access for trucks to the plant floor. Overhead in the factory area a minimum of visible service facilities; underground a myriad of pipes to distribute the air, water, gases, and electricity essential to manufacturing operations. Well heated, well lighted, well ventilated for worker comfort. And a management conscious that the maintenance of high morale makes for loyalty, for efficiency, for uninterrupted progress. The "forgotten third" of a man's hours made more comfortable, more worthwhile, *more profitable* for men and at the same time for management.



Walnut paneling, with brass trim; tinted horizontal wall panels; brown rubber tile . . . Production control office . . . "At sea" in the club room (many fittings from the Morro Castle) . . . "Galley" can serve anything from a sandwich to a banquet

How 100 BUILDINGS ARE

The Story of CLEARING INDUSTRIAL DISTRICT

Our long experience in design, construction, and maintenance has convinced me that buildings have an extensive favorable effect upon production costs when they permit:

- **ECONOMICAL LAYOUT OF PRODUCTION EQUIPMENT.**
- **FLEXIBILITY FOR EXPANSION OR CHANGE OF PRODUCT.**
- **MINIMUM CONSUMPTION OF TIME AND POWER IN HANDLING MATERIALS TO, FROM, AND THROUGH THE PLANT.**
- **ADHERENCE TO THE RIGHT QUALITY FOR THE JOB.**
- **GREATEST WORKER CONVENIENCE AND SATISFACTION.**

H. PERRY PHELPS
Vice President and General Manager
Clearing Industrial District

ADJACENT to the world's largest railroad classification yards, the Clearing Yards of the Belt Railway of Chicago, is the Clearing Industrial District. Here are 108 plants and warehouses representing practically as many industries.

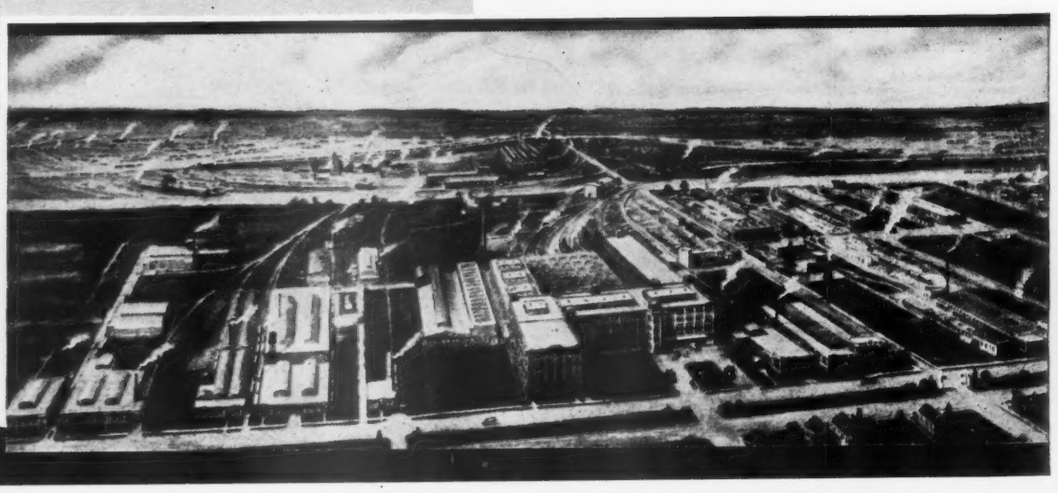
Many are large factories—the largest plant of Continental Can Company; the factory where all Pepsodent products are made for the American market; the home of Crackerjack and Angelus marshmallows; Borg Warner Corporation; Visking Corporation, which produces edible sausage casings for most of the nation's meat packers; Buick's distribution station for parts used throughout the Central West; Olivilo Soap, and a host of others.

RAILROADING ENTERPRISE

This development, which might be likened to a real estate subdivision for industry, did not simply spring into being. It had its start back in the early 90's, purely as a railroading enterprise. A. B. Stickney was then president of the Chicago Great Western Railway.

Stickney saw the need for a more efficient interchange of freight cars between the railroads which make Chicago the world's greatest railroad terminal. He set out to acquire a tract of land three miles square, which was to be laid out with tracks, yards, and industrial sites in such a way as to facilitate the interchange of freight.

Unfortunately for his plans, the



KEPT IN TRIM

panic of 1893 intervened and the plan went into a phase of inactivity. About 4,000 acres of farm land had already been acquired, however, and this tract was maintained intact through the efforts of H. H. Porter, then chairman of the Chicago and Eastern Illinois Railroad Company.

FIVE YEARS LATER

By 1898 the panic conditions had cleared away with the election of McKinley and the industrial revival, and Mr. Porter revived the undertaking. He and his associates worked out the type of railroad yard which they felt would best meet the needs of the roads and serve as a clearing house for freight—where freight trains could be broken up and resorted, where L.C.L. shipments could be interchanged, where cars destined for home roads could be taken back.

The project was financed and completed within three years. But there remained enough lack of agreement among the railroads as to operation so that the clearing yard was not much used.

Then, in 1912, the Belt Railway of Chicago organized and leased a part of the Chicago and Western Indiana Railroad, including the Clearing Yard. While the Chicago and Western Indiana was owned by five trunk lines, eight additional lines were included in the ownership of the Belt Railway. It greatly enlarged the yard, and in 1913 put it into operation along the lines originally contemplated more than 20 years earlier.

The Clearing Yards are the world's largest hump yards. Trains brought here are uncoupled from their locomotives and pushed to the hump by a Belt Railway engine. The cars are brought to the top of the hump, uncoupled from the train and rolled down the hump to the switchtrack assigned to the road which will next carry them. All this is operated by electrically controlled switches in a head house at the hump. Long trains are broken up in unbelievably short time and the cars are promptly on their way to destination.

When the Clearing Yards were purchased by the Belt Line in 1912, the remainder of the land, approximately 3,000 acres, was left in the hands of the Clearing Industrial District, which is a corporation owned principally by substantial Chicago and eastern interests.

A LONG, LONG WAY

There had up to this time been little industrial development here, for the good reason that the district was so far distant, in travel time, from Chicago and from sources of labor. But as street car lines approached, and the automobile became generally used, this distance shrank.

Today the district is half an hour from the Loop by automobile, residential districts have grown up around it, labor supply is ample. The district is paralleled by the Chicago surface lines, with Chicago carfare to all parts of the city.

From the standpoint of rail shipment, Clearing industries have the advantage of turning over their cars to the Belt Line and having these delivered to the trunk line practically the moment they are pulled off the private siding. Every factory site has its private track, and the plants are all built to permit of the easy use of freight cars. All tracks are depressed so that car floors are at plant floor levels. And the layout of the district is such that at only one point does a railroad intersect a street.

Although adjoining Chicago on three sides, the district is not within the city limits and has the same political status as farm land. It buys water from the Chicago city supply, and provides its own police and fire protection with well-organized departments using modern equipment, such as police radio squad cars.

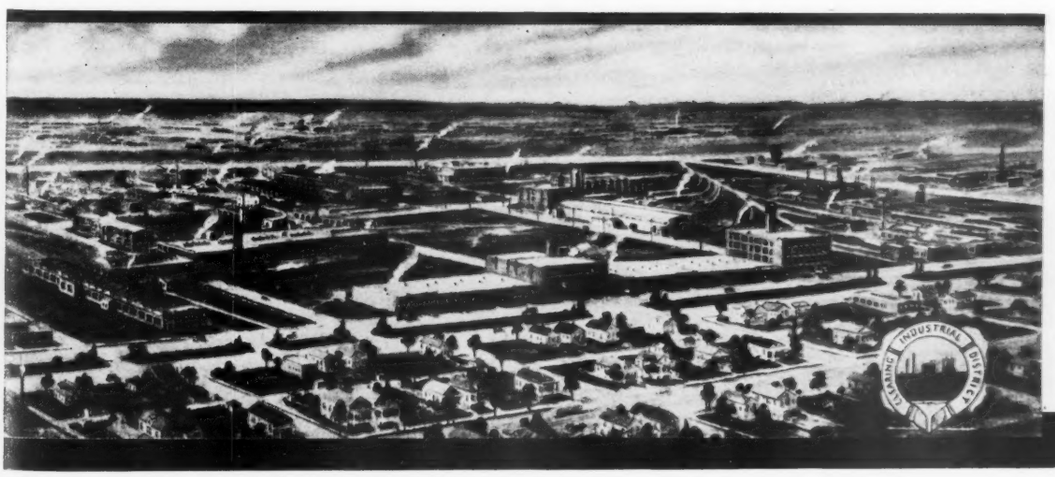
The streets and parkways are the property of the district, have never been publicly dedicated, and are maintained by the district. There are no residents within the district, and no residents are permitted within the district under the terms of the deeds and leases made whenever land is turned over for private use.

20 ACRES A YEAR

Of the 500 acres now in active development, 300 acres are in industrial use; the remainder is being put in use at the rate of about 20 acres per year.

Almost all of the structures erected since 1921 have been built by the district's construction department, and most of those prior to 1921 were contracted by the district. In any event, the district usually finances the building, and turns it over to the manufacturer under lease or contract.

Because of the comparatively low land values, single-story buildings predominate. Practically the only exceptions are in lines of manufacture where gravity is required for handling between processes. Buildings are erected to the manufacturer's requirements, but by reason of experience and



Several years ago an artist painted this picture of the Clearing Industrial District. Not all of its 108 plants are shown

standardization most of the buildings are built in multiples of a standard monitor bay 20x50x70 feet.

With materials always available for erecting buildings in these units, the construction department of the district is able to have a new building ready for occupancy in unbelievably short order. Standard practice is for buildings on main streets to show face brick, stone, or cast stone fronts, and usually common brick on other walls.

To provide for future expansion, the rear wall is usually erected as a simple curtain beyond which it is possible at any time to hook in the members for a new bay or bays, complete the addition, then simply knock through the wall.

Leases or purchase contracts generally provide that the manufacturer is responsible for maintaining the building in good condition and the district people inspect periodically to make sure that plants are not being permitted to deteriorate. The district maintains a steady force of men in the building trades, with a foreman for each major trade, and stands ready to handle repair and maintenance work, as well as additions and new plants.

Across the street from the district—to escape the no-resident ruling—in Chicago, stands the administrative building housing the administrative offices of the district, plus a good many service facilities. The first floor contains a large restaurant, hospital facilities, a Chicago branch postoffice, etc.

BILLIARDS AND BOWLING

The second floor contains the operating offices of the Clearing Industrial District, and the Club Rooms of the Clearing Industrial Association, a co-operative organization of industries in the district. The club rooms include dining room, lounge, billiards, bowling, and other services of a similar nature.

The third floor has sleeping rooms which are available to all industries of the district, used to some extent by unmarried executives of the plants and to a greater extent for visiting officials, salesmen, and the like.

Industrial occupancy of the district is steadily growing. During the worst of the depression, only a handful of Clearing manufacturers fell by the wayside, and by 1935 these vacancies had been 100 per cent filled. In early 1936, as this is written, two new plants are under construction, several additions and two new plants are just about to break ground.

Obviously, there is still a great deal of unoccupied space, with somewhat over 100 plants on 3,000 acres. The development is being held to district areas, however, so that those now under development will be rather well filled before new sections are opened for plant construction. The district has the unique record of having 18 more industries in operation today than were there at the peak of general prosperity in 1929.

Administration building of the Clearing Industrial District

FIRMS IN THE CLEARING INDUSTRIAL DISTRICT

A-1 Union Furnace Fitting Co. (Holland)
Agar Manufacturing Co.
Amalgamated Roofing Co.
American Airlines, Inc.
American Amulco Asphalts, Inc.
American Brake Shoe & Foundry Co.
American Tissue Mills
Angelus Campfire Co.
Arkell Safety Bag Co.
Athey Co.
Athey Truss Wheel Co.
Barrett Wax Co.
Benedict Stone Co.
Bethlehem Steel Co.
Borg & Beck Co.
Brazil Stamping Co. (Sherman-Klove Co.)
Brunt & Co.
Buick Motor Co.
Cellufoam Corp.
Century Vitreous Enamel Co.
Chevrolet Motor Corp.
Chicago Steel Tank Co.
Chipman Chemical Co.
Clark Electric Water Heater Co.
Clearing Bldg. Mat'l & Coal Co.
Clearing Express Co.
Clearing Machine Corp.
Clements Manufacturing Co.
Commerce Petroleum Co.
Continental Can Co.
Cracker Jack Co.
Crescent Engineering Co.
Crooks Terminal Warehouses
Dabrol Products Co.
Eagle Steel Wool Co.
Educator Biscuit Co.
Economics Laboratories
Electrical Research Products, Inc.
L. B. Foster Co.
Lloyd A. Fry Roofing Co.
Fulton Asphalt Co.
General Printing Ink Corp.
Great Lakes Spring Corp.
Great Western Paint & Mfg. Co.
Gustin-Bacon Mfg. Co.
Hamler Boiler & Tank Co.
W. D. Hodson Corp.
Illinois Bottled Gas
Inland Glass Works, Inc.
Jensen Radio Mfg. Co.
Johnson & Johnson
Wm. F. Klemp Co.
H. Kohnstamm & Co.
E. M. Laird Airplane Co.
Lake Shore Oil Co.
Lamson and Sessions Co.
Landon Cartage Co.
Lock Joint Pipe Co.
James H. McCauley, Inc.
McGraw Electric Co.
McGrew Paint & Asphalt Co.
Massey Concrete Products Co.
Met-L-Wood Corp.
Midway Chemical Co.
Morrison Railway Supply Co.
Murphy Varnish Co.
L. E. Myers Co.
National Aluminate Corp.
National Concrete Metal Forms Co.
National Oxygen Co.
North American Warehouses, Inc.
Ohmlac Paint & Refining Co.
Arthur J. O'Leary & Son Co.
W. Q. O'Neall Co.
Paige Jones Chemical Co.
Parsons Ammonia Co.
Pepsodent Co.
Perkins Products Co.
Public Service Co. of Northern Illinois
Rap-In-Wax Paper Co.
Reade Mfg. Co.
Roberts Brothers
Rusco Products, Inc.
Richardson Co.
Walter H. Schenk Co.
Servicised Products Co.
Silica Brick & Engineering Co.
S.O.S. Co.
Standard Oil Co. of Indiana
Star Service Hanger Co.
Superior Flake Graphite Co.
Swan-Finch Oil Corp.
Teleweld, Inc.
Townsend Co.
Trumbull Asphalt Co.
Visking Corp.
Western Electric Co.
Whitaker Mfg. Co.
Wilson & Bennett Mfg. Co.
Wizard, Inc.
Allen B. Wrisley Co.

CLEARING INDUSTRIAL DISTRICT INSPECTION OF BUILDINGS

DETAIL INSTRUCTION TO BE FOLLOWED AS GUIDE ONLY

HEATING SYSTEM:
- Does boiler get water from domestic service?
- Does boiler get water from condensation pump?
- Does boiler get water from automatic feeder?
- Does boiler leak?
- Does boiler need cleaning of flues and breeching?
- Does water line fluctuate?
- Do motors on unit heaters need oiling?
- Do motors on pumps need oiling?
- Do pumps return water to boiler automatically?
- Are grates in boilers warped or out of alignment?
- Does oil burner operate without adjustment and without smoking?
- Are all pipe hangers in place?
- Do steam lines sag?
- Condition of unit heaters.
- Condition of radiation.
- Has tenant altered system in any way?

RUBBISH:
- General neatness.
- Any undue fire hazard?
- Are track and shipping platform clean?

BACKFILLING:
- Are all exterior walls protected against frost?

DRIVEWAYS:
- Condition of concrete.
- Is drain working?
- Condition of curb walls.
- Is layout efficient?

CONCRETE WALLS:
- General condition. Any cracks or veins?

CONCRETE FLOORS:
- General condition.
- Any overloads?
- Expansion joints.
- Has tenant undermined floor?
- Has tenant broken up floor?

CONCRETE POSTS AND STACK FOOTINGS:
- General condition.

CONCRETE SILLS:
- Any large cracks on account of expansion?
- Is joint between steel sash and concrete tight?
- Has tenant damaged sills?

STRUCTURAL IRON:
- General condition.
- Connections.
- Angle edges on platforms.
- Post corbels—Watch bolts.
- Post bracket—Watch bolts.

BRICKWORK:
- Pointing.
- Frost action.
- Sills.
- Coping.
- Door jambs in brickwork.

TILE PARTITIONS:
- Pointing.
- Door jambs in tile.
- Have tenants weakened partitions?

POSTS:
- Have they twisted?
- Have they checked excessively?

GIRDERS:
- Have they checked excessively?
- Have they twisted?
- Any excessive loads?

POST ANCHORS:
- Are all lag bolts in place?

JOISTS:
- Any excessive loads?
- Have they cracked?
- Have they checked?
- Have they twisted?
- Has tenant altered them?

BRIDGINGS:
- Are they all in place?
- Are they well nailed?

LINTELS:
- Have they sagged?
- Have they shrunk?
- Is sash held tight?

BRACING:
- Are all bolts tight?
- Is bracing sufficient?

TRUSSES:
- Are all bolts tight?
- Have trusses twisted?
- Any excessive loads?
- Has tenant altered them?

MONITOR SILLS:
- Have sills shrunk?
- Are they high enough to hold out snow?
- Are they water tight?
- Do they hold steel sash tight?

ROOF BOARDS:
- Are they well nailed?
- Any undue shrinkage?
- Has tenant altered roof boards needlessly?

SHIPPING DOORS:
- Operation.
- Condition of hardware.
- Condition of repair.
- Has tenant altered?

SMALL DOORS:
- Operation.
- Condition of hardware.
- Condition of thresholds.

TRIM:
- General condition.

WOOD SASH AND FRAMES:
- Operation.
- Condition of hardware.
- Sash cord and weights.

STAIRS:
- General condition.

STUD PARTITIONS:
- Any settling?
- Condition of plaster.

MAPLE FLOORS:
- Any shrinkage?
- Any warping?
- Is floor level and wall nailed?
- Does floor creak?

PLUMBING:
- Condition of meter.
- Condition of fixtures.
- Are all faucets tight?
- Are pipes sweating?
- Are pipe hangers in place?
- Are pipes pitched properly for draining?
- Is water supply sufficient?
- Are drains and sewer working properly?
- Are downspouts and heads working properly?
- Is sewer sufficient to carry off water?
- Has tenant altered system?
- Are fixtures secure to wall?

STEEL SASH:
- Is sash tight?
- Condition of paint.
- Operation of vents.
- Condition of hardware.

GLAZING:
- Number of lights to be replaced.
- Condition of putty (watch back putty).

STEEL STACK:
- Condition of paint.
- Condition of guys.
- Condition of anchors and deadmen.
- Is stack plumb?
- Has stack been cleaned?
- Is painter rigging serviceable?
- Condition of stack foundation.
- Are sections welded and calked?
- Is hood secure and does it allow sufficient ventilation?

SHEET METAL:
- General condition.
- Are joints well nailed and soldered?
- Condition of paint.

SKYLIGHT:
- Operation.
- Condition of paint.
- General condition.

ROOFING:
- General condition.
- Flashings.
- Has tenant driven nails or cut holes?

ELECTRIC WIRING:
- Has tenant altered system?
- Is conduit well fastened?
- Any fire hazard?
- Any sockets broken?
- Any amateur wiring?

PAINTING:
- General condition.

WHITEWASHING:
- General condition.

SPRINKLER PIPING:
- General condition.
- Is it holding pressure?
- Are pipe hangers in place?
- Do valves function?
- Check with insurance company report.

TANK AND TOWER:
- General condition.
- Rivets.
- Ladder.
- Bands on tank.
- Condition of wood.
- Boxing.
- Are pits drained?
- Pit covers.
- Condition of paint.
- Tower foundation.
- Roofing on tank.

Note:—On the inspection sheet as arranged for use, columns are provided in which the inspector can enter notes concerning "Condition of Repair" and "Suggestions for Improvement, Cause for Failure, and Means of Obviating Future Trouble"

CLEARING INSPECTION AND MAINTENANCE PRACTICES

NO MATTER how well constructed, no matter how excellent the materials, buildings require frequent inspection and careful maintenance if they are not to deteriorate. To avoid the waste and loss of needless deterioration, the Clearing Industrial District has found it most profitable to maintain an organization which includes enough of experienced men to handle problems of new construction, of inspection, and of maintenance as they arise.

For some few highly specialized departments of this work, subcontractors are used instead of salaried men; such contractors work so closely with the district, however, that they function as smoothly as if they were on the payroll.

In subsequent pages will be found detailed outlines of this organization's approach to the various divisions of the buildings and maintenance problem, such as roofs, floors, walls, paint, and the like. Right here we are confined to the more general aspects of the problem. And of these, no single phase is more important than organizing to give it adequate attention.

Architectural, engineering, and construction are the three divisions into which this work is broken down at Clearing. A drafting department is manned with men competent to make building inspections, and any newcomer lacking such experience receives a blueprint guide (reproduced on page S-227) by which to work until his education has been completed to the point where he no longer needs this assistance.

This is a working tool for a man lacking a background of inspection and construction experience. It may prove useful for many plant men to whom building maintenance must be only a portion of their responsibilities.

The policy of doing its own building and its own maintenance work, with the exception of a few trades regularly sub-contracted, arose at Clearing in 1921. At that time, several contractors failed in the progress of building jobs, leaving the district to pay twice for some of the work they had done or had in progress. The district picked up where the failed contractors had halted, and since then has done its own work.

Prime reason for continuing this

Three of Clearing's plants. From top down, The Pepsodent Company, Clements Manufacturing Company, Murphy Varnish Company

policy has been the ability to estimate rapidly and get quick action on jobs. This is often important from the standpoint of determining whether a new factory will come to Clearing or go elsewhere.

UP IN THREE WEEKS

The Clearing record on hurry-up construction is the erection of a building 200x100 feet, one-story monitor type, brick walls and concrete floors, complete with boilers, plumbing, and all other equipment of the structure, so that the manufacturer moved into the building exactly three weeks after the contract was signed.

Because of the magnitude of the plant, which is the composite of the 108 industries in this district, it has been found most economical to employ a steady force of workmen in most of the building trades, with full-time foremen who are competent not only to supervise their men but also to keep a watchful eye on problems of maintenance and inspection.

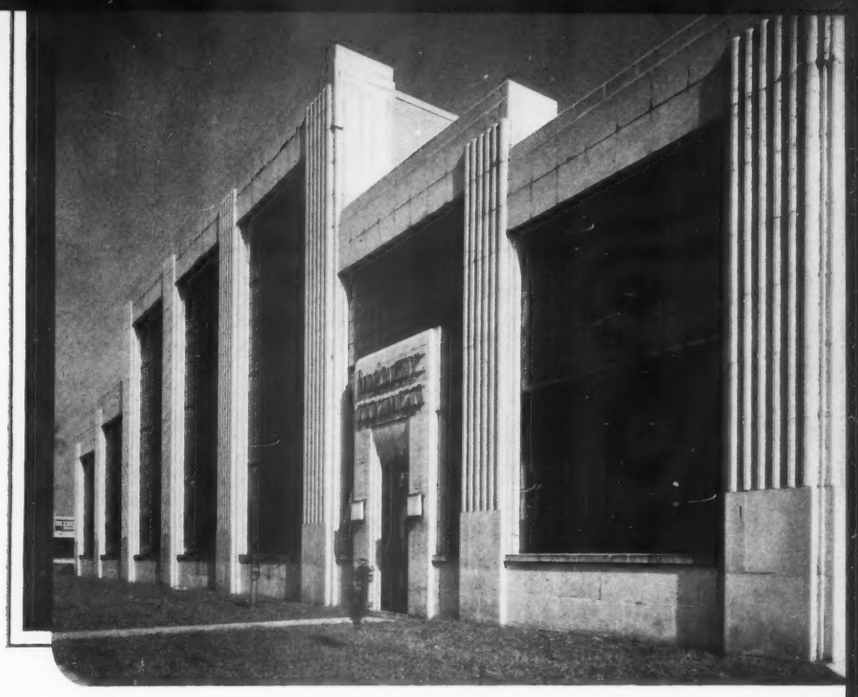
After all, when a question arises in respect to painting, the practical experience of the painter foreman must be respected both as to the condition and as to the cure. Likewise in respect to foremen in such lines as masonry and pointing, carpenter work, and so on.

Items to be watched for in building, inspection, and maintenance are so many that it is almost hopeless to attempt to mention even the most important. In roofs, for example, there are such obvious failure points as surface cracks and blisters, flashings and joints—but there are other types of failure that can be guarded against by proper care in original construction or subsequent alterations, which can be found only by alert inspection, and which, if not promptly cured, may cause costly structural deterioration. As the Clearing people tell the story, it is about like this:

Our basic policy of building and maintenance may be expressed rather simply. We use the best materials which are commercially available, by which we mean the best materials which are not expensive out of proportion to their margin of superiority. We use the best workmanship we can get, having learned from long experience that really skilled labor at commensurate wage scales turns out more units of work per dollar of wage, leaving the added quality of the skilled man's work as a plus element at no cost to us.

BEST TIME TO STOP FAILURES

We inspect frequently and carefully, because the most economical time to stop a failure is at the earliest possible moment after it is under way—"a stitch in time saves nine." And we never defer maintenance after the need is discovered, for we have learned from long and occasionally painful experience that the cost of doing the work later invariably turns out to be many times the cost of doing it earlier.



A typical Clearing front door—that of the Clearing Machine Company

For instance, it may seem expensive to do a thorough job of pointing a masonry wall at the first sign of hair-cracking or crumbling. But the entire wall can be well pointed at a cost less than that of tearing off several courses and relaying, plus repointing the balance of the wall—and this is what we are bound to face after a couple of winters of needless neglect.

CHEAPER TO DO IT NOW

So it is with the exterior paint. When outside steel or iron, say window sash, needs a coat of paint, this will cost $1 for every $6 that it would cost a year or two later to scrape and scale off rust and corrosion preparatory to pointing. The single dollar may be spent grudgingly for the purpose, but it is a lamentable situation indeed when six dollars are required to get a dollar's worth of results.

Floors bring their own particular problems, depending upon the type of floor and the type of occupancy. Within the Clearing district we have several types of floors, with concrete in the largest volume, followed by maple. Each of these requires specific types of inspection.

For example, concrete usually goes at wearing edges, whether these be expansion joints, door openings, or whatnot. Maple floors fail first under unduly heavy traffic loads, as before an elevator or at the intersection of two main trucking aisles. Precautions can be taken, well in advance of failure, to prevent failure of either type of floor surface. Such precautions will, of course, ordinarily be taken only when and if inspection discloses the need.

Therefore it is important that anyone charged with responsibility for a plant building know where to detect incipient trouble, and how to check it before it becomes serious. Likewise, in planning the building, it is usually possible to forestall future expense by some prevision of where trouble would eventually arise without preventive measures.

Heating systems have their weak points—the weakest of which is the possible failure to obtain water. Strangely enough, adequate water supply seems taken for granted by most of the men who operate boiler rooms. Therefore we check and double check to make sure that we are not going to awaken some morning to a cracked or burned-out boiler section.

And just because we know that the system is set up this year to be foolproof is no reason for neglecting it next year. There is always present the amateur plumber or steamfitter, ready to make some haywire change without comprehension of its effect on the system as a whole. For that reason, we check the system every year before the onset of the heating season.

ELECTRICIAN HAD THE FLU

The same is true of wiring, both for light and power. No matter how conscientious the management, no matter how careful the plant electrical men, there will inevitably arise places where someone with an itch for originality will hook some bell wire into a 110-volt lighting line and then put an overload on the working end. There will always be the circuit wired by the power plant engineer during the week the electrician was home with the flu.

And there will be places where a steamfitter running a process line pulled some conduit out of his way and did not bother to fasten it back. In brief, despite all normal precautions, weaknesses will creep in on occasion, and the only way to find these in time and remedy them is to go hunting with a competent inspector.

It is, therefore, important that any plant be organized to give adequate at-

IN HOUSING industrial equipment for the purposes of manufacture, materials of construction and auxiliary equipment must be selected to fit the building to the work to be done. Roofs and walls, for example, serve primarily to keep out the weather, but they must also be considered as to their insulating properties, first cost, freedom from excessive maintenance, and appearance—which really might be called advertising value. Floors must carry loads with safety, yet satisfy the requirements of light or heavy usage, and lend themselves to low-cost maintenance. Paint must serve the dual purpose of dress and utility.

Heating, air conditioning, ventilating, and lighting equipment affect both product and workers; ought, therefore, be tailored to the job.

When materials of construction and auxiliary equipment are the right quality for the job in mind to start with and are then properly maintained, they will meet the most exacting requirements.

F. C. FOLTZ
Architect and Construction Manager
Clearing Industrial District

tention to its buildings, from roof to tunnels, and from shipping platform to president's office. It is necessary, in the interests of economy, that somewhere there be a trained man or trained men who know how to plan for alterations and expansions, how to check that these plans are carried out in detail, how to inspect for not only the obvious deteriorations but also the more insidious failures, how to remedy these structural ills by the best method at the lowest cost.

Economy and low cost are stressed. In this connection, note that many times economy dictates the purchase of materials of highest quality. But note, also, that this is not always true. Sometimes the difference in cost, figured at compound interest, and the obsolescence which sets in irrespective of quality after a period of time, make preferable the choice of a cheaper product.

BIG PLANT, LITTLE PLANT

The building organization may consist, as does that of the Clearing Industrial District, of a dozen or more specialists, along with foremen and full-time work crews. It may consist of one man, perhaps the plant engineer, sufficiently experienced to supervise these activities and to have them carrier out by contractors. It may consist even, in a small plant, merely of a working arrangement with an outside consultant who knows the field in general and this particular plant as one of his specialties. Whatever the size of the plant, and whatever the organization it can most economically employ for the purpose, someone is required to take care of the building if the plant has a building of its own.

BETTER RESULTS, LOWER COST

The reasons why, of course, are simply comprehended. In planning a new plant or an extension, in planning extensive alterations or repairs, an experienced, competent background of structural experience will assure better results at lower cost. As for inspection and maintenance, it is unfortunately true that no matter how well built the structure, it is bound to deteriorate.

The one workable solution to this problem is to catch each deterioration at its onset, remedy it at the lowest cost because of its incipiency, and thus save money later on.

ROOFS

A GENERAL RULE about roofs is that they fail first in the flashings, though sometimes on the flat. Roof inspection is at Clearing considered the one most frequent type of inspection. General practice here is to inspect each roof monthly. This sounds like a good deal more of a task than it actually is, for an experienced roofer can go up and look around sufficiently for a working inspection in a very few minutes on a plant of ordinary size, say 100x200 feet.

The reason for this frequent inspection is not that roofs fail frequently, but rather that here as nowhere else about the ordinary factory building it is possible to save nine, or ninety, stitches by the traditional stitch in time.

Most of the roofs in this district are built-up asphalt. Some few are of tar and gravel. Most of these roofs are on wood decks, though some are on concrete or insulite or gypsum board insulation.

FLASHING FAILURES

The failure most frequently encountered is in the flashing, which may be found pulled away from wall, chimney, ventilator, or skylight. Frequent inspection catches these before they are really bad—usually before they have started to leak. Caught early enough, a pulled-away flashing does not have to be taken off. It is easier and cheaper to go right over and above it with a new flashing. Composition flashing is the rule here. With metal flashing, a failure means that the flashing has to be raggled out and replaced, usually using plastic cement.

Failures on the flat are ordinarily of blisters or cracks. Here, again, such a failure caught early permits a quick repair by stripping with new felt and going over the repair. Leaks of this kind are of many origins—machine vibration just beneath, shrinkage of lumber through seasoning, roof boards or wooden members lower in the structure. Such shrinkage usually tears the roofing felt.

Another frequent need for roofing attention comes through the unknowing attempts of the manufacturing departments to penetrate a roof for some purpose without benefit of roofing skill. A blower, a ventilator, an exhaust—any kind of opening through the roof—needs skilled attention at the time it is made, not later on.

REAL JOB OF ROOFING

More times than not, the mechanics installing the new equipment consider they have made a 100 per cent job by going around the edges of the opening with plastic cement. Frequently this

results in a leak reported within a few days. Then the roofers go on the job and do a real job of flashing.

Leaks frequently occur around downspout heads—roof drainage at Clearing is handled by inside downspouts instead of gutters. Most frequent cause here is wood shrinkage through seasoning. The wooden members in the structure shrink, the downspout is non-shrinking, so the head may eventually emerge at roof level, leaving a crack around it—or, if the bond holds, then a water accumulation occurs to the depth of the shift in levels.

NO LEAK, THEY SAY

Often a leak around a downspout is discovered on roof inspection, only to be denied flatly by the building occupants. They argue, "If there were a leak, we'd have seen it. So there can't be a leak, and there is no sense in our spending money to repair one." The standard procedure to show evidence of the leak is to drill the wall below the leak, disclosing wet plaster.

A leak inside a wall may do worse structural damage than a disclosed leak, for it permits rotting inside the roof-deck and wall and may, in extremely cold weather, result in serious frost damage. Such a leak will eventually, of course, show itself on ceilings or wall surfaces. But the saving of the structure by catching the leak from roof-top inspection is obvious.

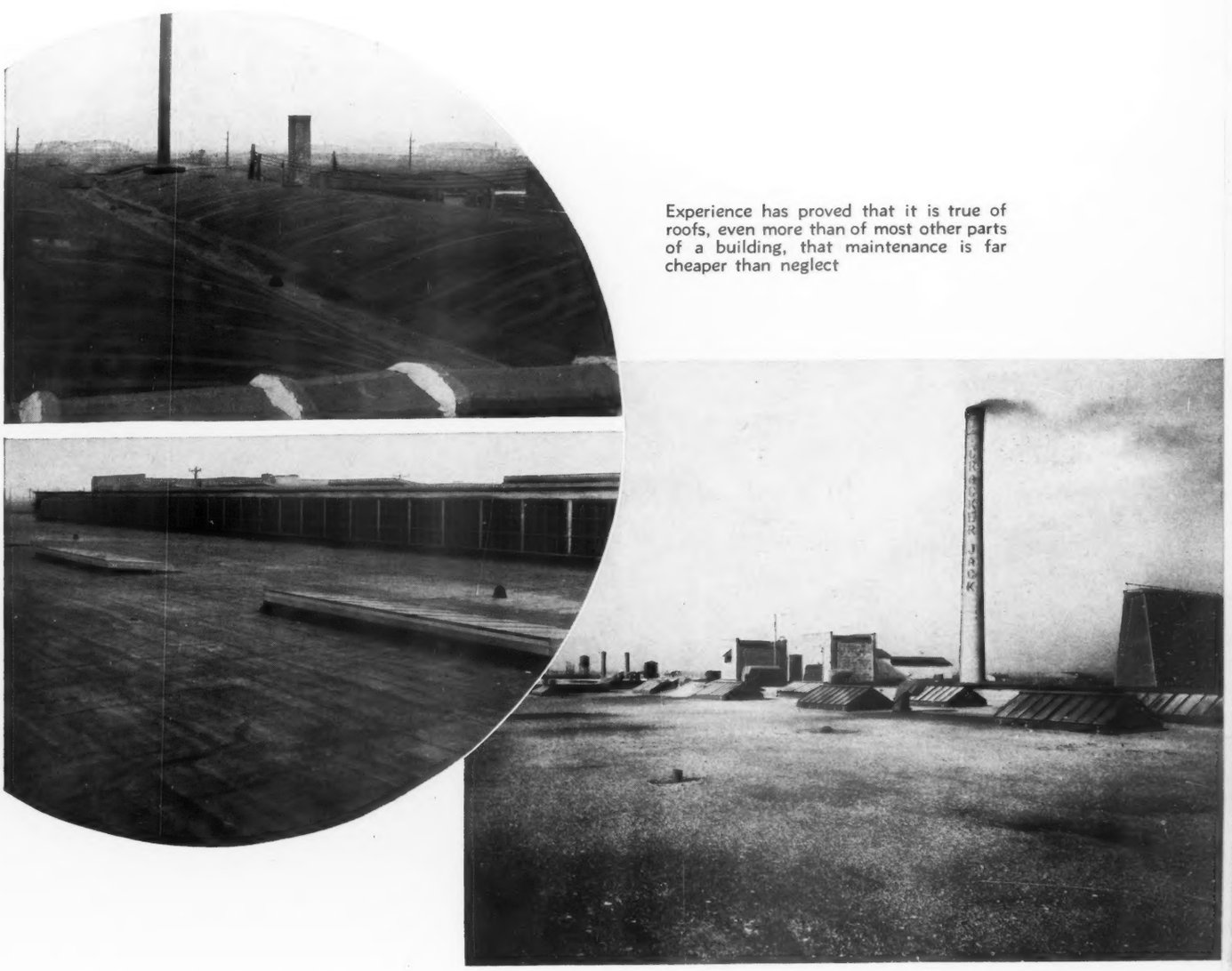
WATER IN THE AISLES

Roof inspection likewise consists of looking at ceilings and walls inside the building. Occasionally a bad leak may be masked on the upper surface and apparent from beneath. It is noteworthy that manufacturing departments seldom report a leak, even though it is staining the ceiling, until water begins dripping into the equipment or the aisles.

Frequently reported roof leaks turn out, on inspection, to be leaks in improperly soldered ventilators or in skylight sash. These jobs call for tinners or glaziers, and are repaired by resoldering, reputtying, or recalking. Where metal flashing comes loose around a ventilator, skylight, or cyclone, soldering often will fix this permanently. It is the roofers' basic principle that where anything comes through a roof there is the usual fail point. Given a roof with no such breaks and there is almost no roof trouble.

As standard treatment, built-up roofs at Clearing are given a coat of hot composition every five years. This restores the natural oils of the roofing, puts new life into the paper, fills up the holes, and makes the roof last indefinitely. Experience has proved that it is true of roofs, more than of most other parts of a building, that maintenance is far cheaper than neglect. The only times when Clearing has to replace a roof is where, for some reason beyond control, it has been neglected.

In 1935 and 1936 there has been a considerable roof replacement in the district, chiefly because buildings owned by the manufacturers themselves had been allowed to go to pieces during depression times. In every instance, it requires only a few pencil figures on the back of an envelope to prove that it would have been much cheaper to keep up the roof than to let it go. Between 1929 and 1935 any building missed not more than two of the scheduled five-year hot coatings. The cost of two coatings is far less than the cost of a new roof.



Experience has proved that it is true of roofs, even more than of most other parts of a building, that maintenance is far cheaper than neglect

FLOORS

ASSUMING a floor properly constructed in the first place its failure depends very largely on the use to which it is put. There are certain specifications which have been proved in the experience of the Clearing Industrial District as desirable for satisfactory service.

For one thing, this experience indicates that no pitch of less than $\frac{3}{16}$ in. to the foot is sufficient for drainage, and this is barely sufficient if the floor is very well laid. On the other side of the equation, a pitch as great as or greater than $\frac{3}{8}$ in. to the foot will cause rolling of trucks and other difficulties. Consequently the rule followed here is that floors are not recommended to be pitched except where a wet process is to be used.

Where sulphuric or other injurious acids are to be used, concrete floors should be covered with at least one inch of asphalt, similar to surfacing used in pavements. This should be carefully turned up at walls and posts. Expansion joints should be used around walls and posts and to divide the concrete floor into areas of not more than 4,000 square feet. Quarter-inch joints are sufficient. It is advisable not to round the edges of the floor at the expansion joints.

For some unaccountable reason, concrete men actually have to be watched to prevent their rounding the edges at expansion joints—it seems to be an old finishers' custom. Rounded edges cost money to make. They provide hospitable crevices for dirt to lodge in. And worst of all, they supply a wearing edge which will fail along a trucking aisle far sooner than a flush joint.

PATCHING CONCRETE

Concrete floors stand at almost the opposite pole from roofs in their need for inspection and prompt repair. When a joint begins to show wear, it is seldom advisable to patch it immediately. On the contrary, the repair will cost less and wear better if that wearing joint is allowed to widen and roughen itself up, to provide a better bond for the patch. Patching turns out most satisfactorily, in the Clearing experience, when done with a material consisting of asbestos, asphalt, and Portland cement such as is provided by manufacturers of patching compounds.

Use of a surface hardened with a silicate base is recommended from experience here. Floors should be redressed in aisles, particularly in trucking aisles, more frequently than on the rest of the area. This not only saves the surface but also holds down the dusting and keeps the plant interior just so much cleaner.

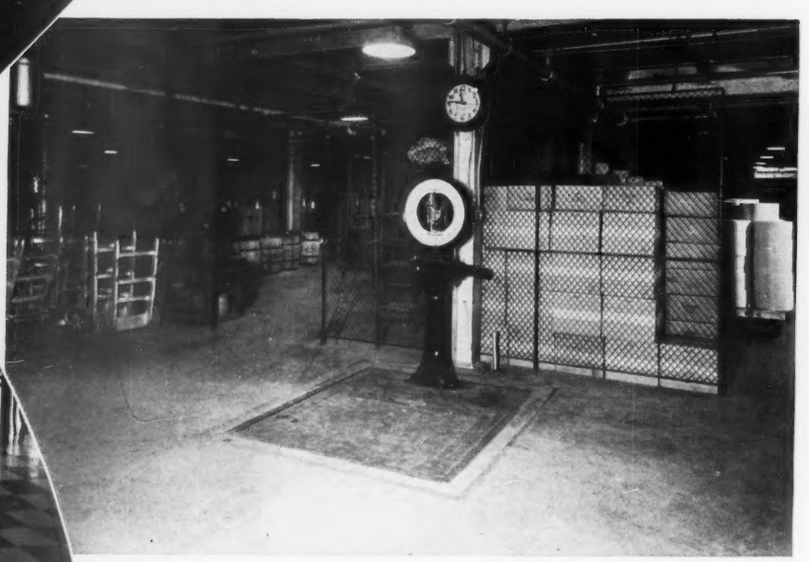
WATCH FOR OVERLOADING

In inspecting concrete floors, the standard Clearing procedure is to check for general condition, condition of expansion joints, and whether the floor is breaking up at any point. Likewise, an attempt is made to find any pieces where the floor is overloaded and to point out this abuse to the occupant of the building. Finally, a check-up is made to ascertain whether the floor has been undermined at any point.

Wherever a drain opening is used in a concrete floor, Clearing recommends that it be a threaded opening supplied with a brass screw plug. Further, that the screw plug be chained to the drain opening. Thus, when a flushing operation has been completed, the only easy way to dispose of the plug is to screw it back to close the opening. The reason, of course, is to prevent any backing up of rain water through floor drains.

In any district where there are acres of factory roofs, all draining through downspouts into the sewers, there is the possibility of backing up as the result of an unusually heavy rain. The chained-on brass screw plug is the perfect antidote for this ailment.

In laying a maple floor, Clearing ex-



Floors bring their own particular problems, depending upon their type and the type of occupancy. Each type of floor requires its own kind of inspection

perience indicates that it is necessary to be alert lest some carpenter or contractor of original bent decides to try some innovations. A maple floor should be laid directly on the sub-floor, over a layer of resinous paper. Several of the earlier maple floors in Clearing plants proved unsatisfactory—creaking, warping and splitting—until, on the first attempt at repairs, they were disclosed to have been laid on one-inch strips. Then there was nothing to do but pull up the flooring and relay it as it should have been laid in the first place.

Inspection of maple floors covers four main points. Has there been shrinkage? Has the floor warped? Is the floor level and well nailed? Does it creak? If any of these faults is found to have advanced to the stage where it interferes with the floor's usefulness, there is nothing to do but cut out the faulty area and patch in a new piece.

USE OF STEEL PLATES

When a region of unusually heavy wear is discovered, steel wear plates may be put on the area as a precaution. However, there is no advantage in using wear plates on too limited an area. If, for example, trucking off an elevator is wearing the floor before the elevator doors, laying steel plates will merely move back the area of excessive wear by the width of the plates.

To be of real benefit, wear plates must be laid far enough to reach the point where the cause of the excessive wear no longer exists. Before an elevator door, for example, the steel plates should be laid over an area large enough to reach the point where the truck traffic disperses to various aisles, and is therefore not so heavy at one point that it will cause the same sort of wear as was previously shown before the elevator door.

Maple floors for office and showroom use are, in Clearing, usually waxed and polished. But for factory use, they are ordinarily not finished in any way. A few plants oil their maple floors, but the general experience has been that this makes the floor slippery when wet, and dirty looking, and which gives no commensurate advantages.

WALLS

MOST exterior walls at Clearing are of face brick, common brick (at rear and sides not exposed to public view), stone, and cast stone. Care of what wood and steel walls are used here is covered in the section on painting, which is included on page S-236.

In inspecting it is well to look for failures first in the joints in the copings, second in the joints between masonry and windows, third in the joints of the masonry itself. The failure to be looked for is haircracks, since these appear first and if remedied in time the failure never reaches the more serious and expensive stage of crumbling.

WHEN MOISTURE ENTERS

Haircracks in mortar cause the most trouble in cast stone, less in natural stone, still less in brickwork. Haircracks permit moisture to enter the wall. They cause the most damage when entry occurs during driving rains in the autumn, since this is when the porous materials inside the wall are likely to be baked out of general moisture. And the damage comes, of course, not from the water itself but from the ice and frost formed when winter comes and heaves the masonry. In many instances ice from water entering through haircracks is formed in joints behind the surface, with disastrous results that require the rebuilding of at least the upper parts of some walls.

The cure for haircracks is as follows: Rake out the hair-cracked joints to a depth of at least one inch, carefully brushing out all loose particles. Carefully shellac stone or cast stone at the joint to keep this material from drawing oil from surface pointing compound. This work should be done on a dry day. Get plenty of shellac in upon the clean surface, fill up the porosity of the stone or cast stone to protect the surface pointing. Then fill these joints with a never-hardening pointing material. This material should be forced into place, and can be lightly sanded on the surface to cut off the gloss.

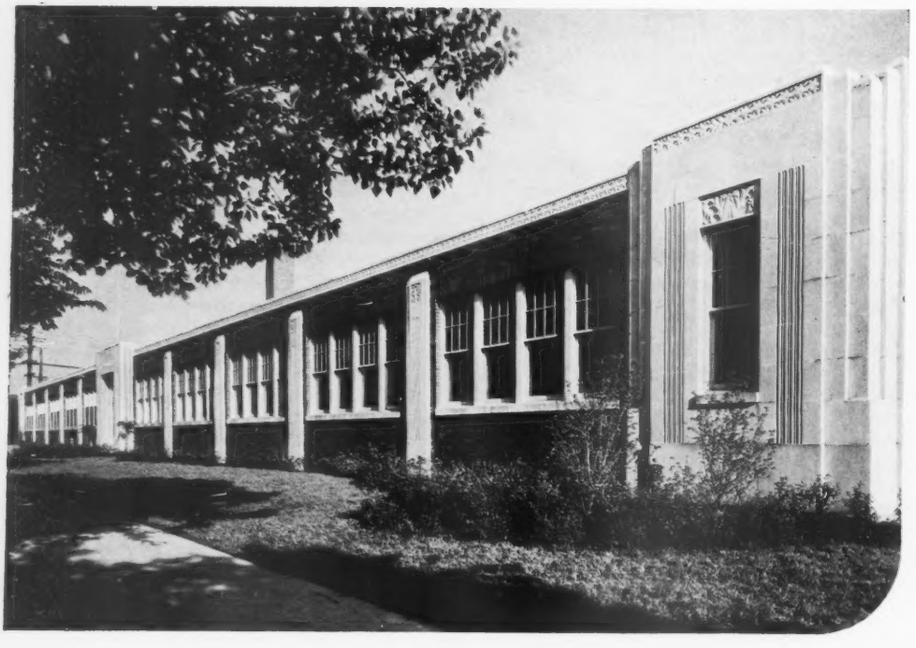
Experience at Clearing has convinced those in charge that the reason for masonry wall failures is in lack of flexibility in the mortar or pointing material at the surface. This is brought out by those walls which were built during the years when there prevailed a fashion for using hard mortars, some of them almost neat Portland cement. The harder the mortar, the greater the trouble with haircracking and crumbling, at least in the Chicago climate. The reasoning gains authority when it is considered that many Roman walls made with extremely well-slaked lime are still standing with little damage from haircracks—most of these, be it admitted, in climates less extreme than those of Northeastern Illinois.

If parapet or other walls must be rebuilt, especially in stone or cast stone work, Clearing experience is that this work should be done only by men sufficiently expert and experienced to use materials with coefficient of expansion approximately equal throughout the thickness of the wall. Moreover, the mortar should be used with shove joints so that as many as possible of the spaces between the backing brick can be filled.

TO ELIMINATE LEAKAGE

The only satisfactory way to eliminate leakage between window frames and masonry, in Clearing experience, is to remove the brick molding from the frame, calk the frame with oakum, cover the oakum with an outside

Most exterior walls at Clearing are of face brick, common brick, stone, and cast stone. A cast stone wall is pictured



Here a face brick wall, with cast stone trimmings. This combination makes a very pleasing appearance—always looks dressy

mastic coating, and renail the brick molding. This has become standard practice not only in maintenance but also in new construction.

In erecting steel windows, butter the mullion with mastic. This makes a very nice job, leak-free, and is especially valuable in windows in monitor skylights. Incidentally, where any process steam is in use, a condensation gutter on monitor windows has proved a great reducer of subsequent maintenance.

Although few wooden exterior walls are used here, certain facts pertaining to the use of lumber have a direct bearing on maintenance costs of walls and other structural parts. It has been found that when a new building is erected with green lumber, there will occur in the natural process of seasoning a cross-grain shrink of at least ½ inch to each 1 foot of depth in the lumber. This has to be taken into account wherever a non-shrinking vertical member appears as an integral part of the same construction. For example, inside down spouts need slip joints.

The subsequent shrink must be taken into consideration in framing wooden joists into a steelbeam, hanging monitor sash where beams and joists are beneath, and so on. To be forewarned of this shrinkage affords opportunity to so construct that in many places no subsequent work will be required to take it up. Likewise, watching for it in the first year or two provides a chance to fill any openings before they permit maintenance costs to pile up.

To beat this tendency, which is present in practically all lumber obtainable for plant construction, the Clearing Industrial District maintains at all times a forward bank of reserve lumber. This is purchased on the Pacific Coast at least six months or a year in advance of anticipated requirements, and is air-dried there and held to the district shipping order. To prevent shrink on roof deck boards, kiln-dried yellow pine has been adopted as standard; this has practically overcome the trouble.

SASH, DOORS, GLASS

Maintenance of sash, doors, and glass is almost entirely a painting problem. Certain precautions pay, however. In installing new metal windows, before glazing, and while repairs are still easily possible, see that ventilators contact with the frames. A sash may be held away by one little burr. If so, a tap with a hammer will suffice—but it is impossible to give that tap after glazing.

Putty in wood windows should be very carefully inspected. Lack of putty causes deterioration, particularly in the joints, and in very short time such sash may go all apart. Wooden sash for erection should be painted immediately on arrival on the job. Waiting until a rain or two soaks them may cause subsequent trouble. And ample paint on sash before glazing lengthens the life of putty almost indefinitely.

YARDS AND GROUNDS

INSPECTION and upkeep of yards and grounds, tanks, towers, fences, tunnels, streets, and sewers fall into two distinct classifications—protective and ornamental. For the purpose of this description the distinction will not be pointed out, and the two will be pretty much intermingled in the various sub-headings to be covered.

Landscaping is, of course, almost purely ornamental. Many firms in the Clearing Industrial District, more particularly those on main through streets and highways, have gone in for landscaping on a rather pretentious scale. Two plants, for instance, employ a full-time gardener and supply whatever additional help is required in busy seasons.

The district every spring seeds all parkways and fertilizes them. Likewise it plants several hundred five-year-old trees along parkways. These are poplars and elms, planted alternately on 20-ft. centers. The poplars, of course, grow more rapidly and are comparatively short-lived. As it works out, by the time the poplars die out, the elms have grown to a size where they require more space, and they fill in the gaps by their growth. The ultimate working out will be elm-lined streets with trees every 40 feet. Trees are given thorough sub-surface fertilization every two years.

From fifteen to eighteen men are required for the spring planting and clean-up work. Two men with hand lawnmowers—power mowers do not fit the comparatively small patches of grass—work full time all summer to keep up with the mowing. All this, of course, is in the public areas.

Individual plants do whatever landscaping they see fit, and maintain it as suits them. Most plants on the main streets have liberal lawn areas, with beds of bushes and shrubs, some trees, and in a few instances both perennial and annual flowering plants.

Direct inspection of yards covers merely undue accumulation of rubbish, plus considerations of fire hazard. Few reminders are needed, however, because of the neighborhood competitive spirit among the plants themselves.

Streets, sewers, and fire protection are the district's responsibility. Streets are principally concrete, and are maintained by the same general standards current in well-managed municipal street work. With experience it has been learned that wide expansion joints are needed in concrete roads, the standard now being one-inch joints every 40 feet.

Where cracks and breaks appear in the pavement, patching is done with asphalt impregnated into a pervious stone. First the concrete is painted with an emulsion of oil, then the asphalt mixture is poured and tamped, and allowed to roll itself in. If concrete starts to crumble, the broken area is

knocked out and the pavement lipped under before pouring new concrete, to give a good joint. Concrete patches are never made in areas of less than four square yards.

Snow removal is a problem carefully watched, since much hauling is done with comparatively low-powered motor-truck tractors pulling large, heavy trailers. This type of vehicle has its difficulties on snowy roads and streets, so the snow-plow service is maintained 24 hours a day, with a small plow ready to go into action immediately and a larger plow at hand on comparatively short notice to the crew. The small plow is under the district police department and is manned by the police.

Regular annual inspection of sewer manholes is maintained, and any accumulations here are removed. Former practice was to send men through the sewer mains every summer to shovel out, but this was proved dangerous by an explosion with fatalities. Whether a workman smoked in an atmosphere of flammable gas will never be known. However, since then it has been policy to send men down only at manholes except in case of emergency. The men go in and clean interior sewer lines only when clogging appears. Catch basins are cleaned twice a year.

Wherever sewer or water main repairs are needed, the effort is to make these outside plant working hours. Fire hydrants are flushed out once a year. Fire protection water is not metered, is classified by the district as water loss. Total water loss between Chicago city meters supplying the water and the metered consumption is about 15 per cent. The piping varies in age from 25 years to a few months.

Annual inspection is made of survey monuments, no-parking signs, speed signs, and the like—plus, of course, special inspection when needed. Vitreous signs are used, to save maintenance, and these are replaced when they go bad.

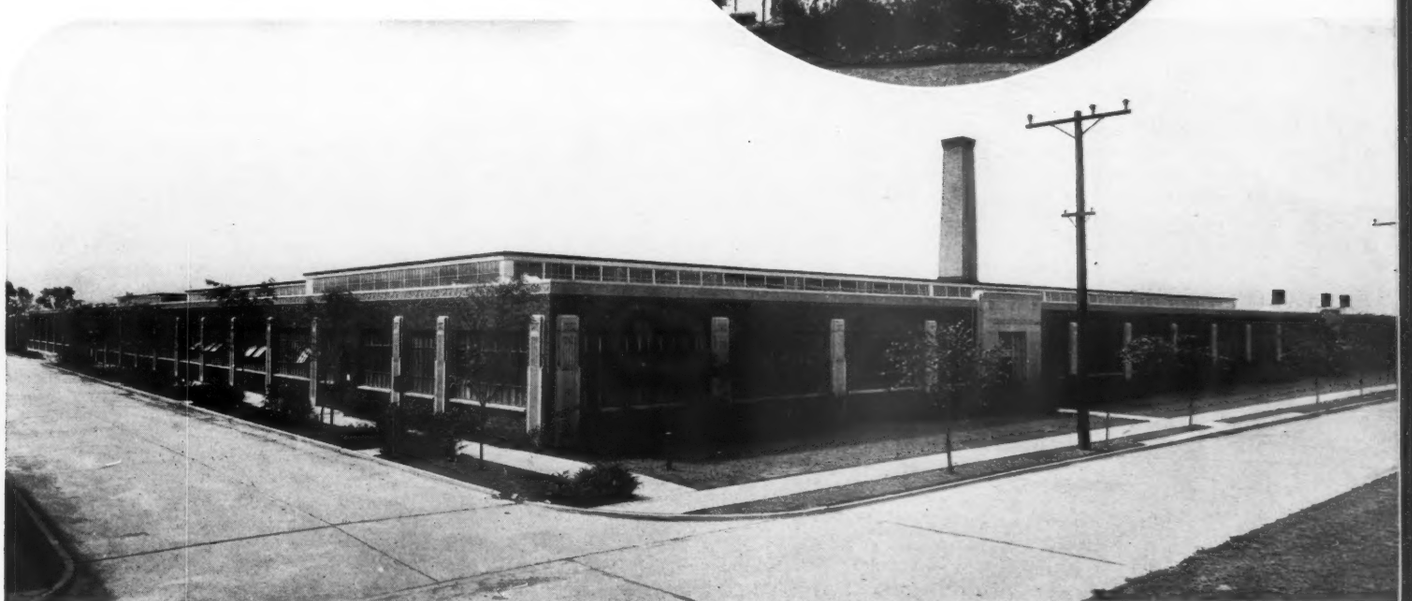
TANKS AND TOWERS

Sprinkler tanks are principally wood, though some few are steel and one plant which requires an absolutely steady supply of process water combines this with sprinkler supply in a sizable concrete emergency storage pool that holds 16 hours' process capacity. Wooden tanks are painted on the outside, partly to preserve them and partly for looks. The general rule is one tank and one fire pump for each half dozen plants or less, and these are gradually being tied together into a system.

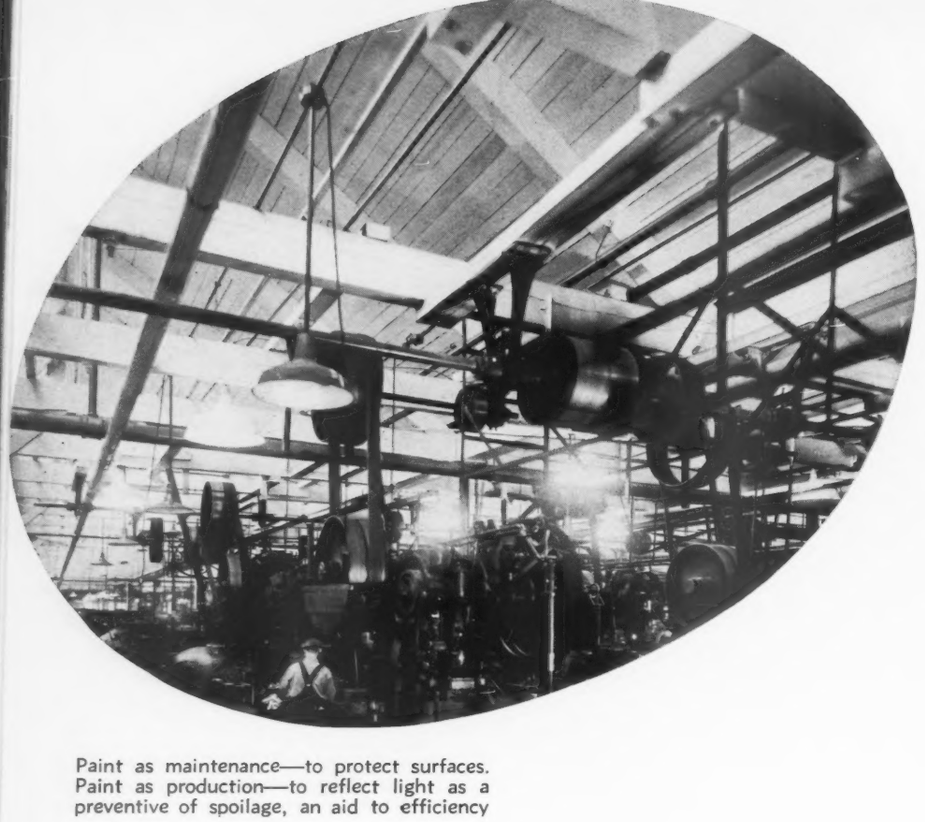
Tank towers require one special precaution, watchfulness that soil does not come up over the concrete footings to rust the iron. Material susceptible to soil water is kept painted with fish oil, including pits under tanks where condensation makes a rust hazard. Aside from this, towers need painting on the same schedule as other outside iron or steel, often enough to prevent rust and corrosion, and oftener still if appearance is a consideration.

Several plants have galvanized fences of woven-wire, none of them old enough to require any attention with a paint brush. Fence footings require the same care as tower footings to avoid rust from wet soil. (This same precaution is needed on ground anchorage of stack guy cables, where neither the cables nor the rings must touch the soil.) One fence, which went through considerable abuse from a former tenant, has been aluminum-painted and is standing up well again.

"Welcome," says the exterior of "Crackerjack." You are certain that fine confections are made within



Grass, trees, shrubs, sidewalks, and curbs give this corner property of Brunt and Company a truly landscaped appearance



Paint as maintenance—to protect surfaces. Paint as production—to reflect light as a preventive of spoilage, an aid to efficiency

PAINTING

INTERIOR painting and exterior painting are, of course, practically two distinct types of maintenance operations. Interior painting is chiefly for two purposes, increased light reflection and appearance, and only incidentally for preservation. Exterior painting, on the contrary, is primarily for structural preservation, secondarily for appearance, and only rarely has any bearing on interior lighting.

At Clearing three types of paint are used on interior work: Oil-bearing white paint; aluminum paint; and water-bearing casein and lithopone paints. Of these, the water-bearing paint is used most extensively, for one reason which may not apply elsewhere. It is the one type of interior paint which the Chicago painters' union permits to be applied with a spray gun. It therefore is first choice for areas where spray-painting is most economical, being supplanted by one of the others in a natural spray area only for a specific reason calling for the other paint.

Since this is a local condition, however, with no bearing on the respective merits of the types of paint, this article will consider the utility of the three types without further regard to what happens to be used most extensively at Clearing.

Where light is a consideration, one of the white paints has first call. Where a maximum of natural light exists, and where artificial lighting is seldom needed, as in a single-story, monitor-lighted plant working only a day shift, aluminum paint gets its innings. It is the experience at Clearing that, whatever may be the theoretical advantages of washable paint inside a plant, plant walls in practice seldom get washed. When they become too dirty to live with they are generally repainted.

Dadoes or wainscotings are painted with any of the three types of paint, with preference for oil-bearing white or aluminum at this low level, and most often with water-bearing above this level. Here it has been found that the slight added expense of a 1½-in. stripe between dado and upper surface is worthwhile in appearance; perhaps the most successful such stripe so far tried has been bright red.

FOR PIPES

Except in plants where a color code is used, Clearing practice calls for aluminum as the most successful paint for pipes. In such non-code plants, aluminum therefore has an advantage as an interior paint because the workmen can paint everything—pipes, steel, wood, plaster—with it, and do not have to spend time cutting in and out. This is done extensively here, since experience indicates that on all except large flat surfaces it is as cheap to paint by hand.

Success and economy in painting, Clearing authorities are convinced, come in the ability to use large rolling scaffolds. They put three or four painters on the scaffold; the painters stay up there painting while a laborer on the floor level pushes them along. Drop cloths are used over equipment. No precautions are taken to keep paint off floors. The laborer below has as part of his duties putting his foot on any floor splotches and scuffing them. Thus scuffed, they wear off with ordinary plant traffic within a week or two. Incidentally, badly soiled drop cloths are not effective, since they spread dust and dirty up equipment. Nor is it necessary to use soiled cloths, for they can be washed very cheaply by the average laundry.

FOR INTERIORS

The effect of well-maintained interior walls upon workers may be gaged by the Clearing experience in renting and selling plants that have been vacated. The prospective buyer or tenant coming in to examine an unpainted or soiled building immediately is either not interested or else thinks he should have it at practically gift prices. Therefore, Clearing paints up the interior before ever showing the plant. The percentage of completed deals has materially increased since this plan was adopted.

For exterior painting Clearing uses principally either lead-and-oil or aluminum paint mixed with a very good spar varnish vehicle, with mixed paints used for special conditions which they particularly meet. The aluminum paint in spar varnish vehicle is used on metal windows, and so on, except in walls of face brick or stone; in these, lead-and-oil is standard, for the better appearance. Where wood is to be painted or varnished, it is primed with white lead.

The importance of using power agitators for outside paint cannot be overemphasized. Clearing uses several of these. They are almost essential to good painting with aluminum. Likewise, they permit buying white lead in the paste and mixing. When a mixed paint is purchased, it, too, goes through the agitator to assure a perfect mix.

FOR EXTERIORS

Clearing experience is that 2½ to 3 years is the economical interval for exterior painting without injury to exterior parts. In special places, where a great deal of steam escapes or there are even slight quantities of acid fumes, painting is of course required more frequently. Inspection calls for finding rust spots greater than ⅛ inch in diameter of pitting; up to this size, they are not considered dangerous. Steel used at Clearing is graphite treated before delivery, and the usual grade of graphite is good enough never to require any subsequent priming coats. Red lead is never used.

It is wise to open ventilators on windows in inspection, since weak spots often develop here due to faulty paint-

ing or subsequent excess condensation. If painting is neglected to the point where wire-brushing or scraping is required, the cost can easily mount to four, five, or six times as much as for a plain paint job. This has been shown repeatedly in the past year or two, when depression neglect has been made up at excessive costs. Incidentally, gutters other than copper and other non-ferrous metal are the most vulnerable spots, and should be avoided in design if possible.

SAFETY IS FIRST

Accident-prevention and liability coverage are of major importance. Painting is the most dangerous of maintenance trades. Greatest possible care is essential in inspection to see that ladders and scaffolding are in almost ridiculously safe condition, and that wherever possible they have grab ropes or rails. For some reason peculiar to the trade, painters seem willing to climb around on the most rickety contraptions, and they must be guarded against their own folly.

Likewise, in spray work the men should be forced to wear respirators under penalty of discharge for the first violation. Also, be sure that plant liability covers this type of work. Many factory liability policies exclude painting and some other trades.

The Clearing experience is that it is better to paint exterior wood and metal work on daywork basis, for if this be contracted it is perfectly possible for the contractor to miss a great many spots, especially in cracks and corners, and there is practically no way for the purchaser to determine the quality of the work done.

Well-trained, well-equipped painters, even though drawing higher pay, can generally produce a larger volume of work per dollar of wages. The added quality of their work makes their employment far more economical. Also, while it is perfectly possible to do successful exterior painting in temperatures as low as 15° F., if the air and surface are dry, both the production and the quality of work drop when the workmen are cold. The time to paint is in summer, late spring, and early autumn.

TO CLEAN GLASS

One little knack worked out at Clearing is that the cost of cleaning glass after painting and glazing can be cut to 25 per cent of any other method. The Clearing method is to use steel wool, dry. This removes paint and putty splattering very rapidly—not a perfect job such as might be expected on a fine residential job, not even clear enough to satisfy the occupant of the big front office, but entirely adequate to plant requirements.

LIGHTING

ACCEPTED standards of lighting in industrial practice unquestionably are too low to provide good working conditions. Too low a lighting intensity leads to manifold difficulties. Improving this lighting intensity at strategic points brings up production, improves quality of work, reduces inspection rejections, lowers the drain upon workers' nervous energy.

The specific type of lighting to be employed varies, of course, with the problem employed. In one of the Clearing plants, where radio loudspeaker coils are wound, ordinary kinds of light sources were found unsatisfactory for the winding department, despite various attempts at improving the job. Eventually an experimental installation of mercury vapor lamps was tried, and it proved exactly what was needed. Now the entire department is using this lighting. It has eliminated glare from the enameled wire, gives sufficient contrast in light and shadow to show up flaws, provides a general lighting level entirely adequate to the task.

WELCOMED BY WORKERS

The bluish quality of the light was so welcomed by the workers, once they became accustomed to it, that presently employees in other departments began asking whether something could be done to give them similar benefits. In these other departments the lighting requirements were not such as to induce the management to authorize the outlay for mercury vapor lighting. However, daylight blue lamps were placed in the regular fixtures throughout the other departments of the plant, with results satisfactory to every one.

Another plant, making automobile clutches, had been lighted to an ordinary plant level with incandescent lamps in enameled reflector bowls. On certain of the operations, however, this gave reflected glare from polished surfaces and failed to show up all flaws. After some months of experimentation, an installation of half a dozen high-intensity mercury vapor lamps was tried out at a particularly troublesome point. These were added to an existing installation of ordinary mercury vapor lamps, bringing the illumination on the operation of machining clutch castings up to a level of 40 foot candles. The results were so surprisingly satisfactory that the plant is at this writing going ahead with installing high-intensity mercury vapor lamps throughout the department, to yield a lighting level at close to 40 foot candles.

Lighting requirements vary so widely according to the type of work performed in a factory department that the Clearing experience indicates

General lighting for average work plus localized lighting for precision work plus correct painting mean "lighting is seeing"

the impracticability of attempting any great standardization of plant lighting. In contrast with the intensity of 40 foot candles cited above, there are other plants here doing entirely satisfactory machining work under 12 to 15 foot candles, using glass and steel reflectors.

OTHER LIGHTING JOBS

In still another plant, where most of the work is continuous-process on automatic machinery requiring a minimum of attention, 10 foot candles is considered adequate by those closest to the problem. This latter plant, incidentally, has wiring capacity sufficient to compensate for a 2 per cent drop in voltage from resistance at the end of the circuit, thus assuring that the lighting does not fall below the quantity desired, so long as other factors remain constant.

Local lighting is employed in several Clearing plants where a high level of general lighting would not be justified. In one plant, for instance, an unusually high lighting level well diffused is employed at the inspection benches for a material which practically defies inspection under ordinary lighting.

In general, lighting inspection and specification are left up to the manufacturing firms rather than supervised by the district, on the assumption that this is a function of production rather than of structure. The annual inspection of the district covers only five major wiring points:

1. Has occupant altered the system? (if so, are alterations satisfactory?)
2. Is conduit well fastened?
3. Any fire hazards?
4. Any amateur wiring?
5. Any broken sockets?

Most of the manufacturers maintain sufficiently close relationship with the district's electrical sub-contractor so that they have a considerably more detailed inspection made rather frequently.

One plant holds the sub-contractor on contract to make a regular and detailed inspection of its entire plant electrical system four times a month. On this inspection the condition of wiring, both for light and power, is checked. Also, a quick-reading foot candle meter is used to check lighting intensities to see that they are maintained at predetermined standards, and whenever any deficiency is detected the cause is looked for first in such usual sources as fixtures in need of cleaning and lamps in need of replacement.

POINTS CHECKED

The usual inspection offered by the sub-contractor is that whenever, from his knowledge of the plants, he feels there is any probable need for inspection, he sends in someone to go through the plant looking for major maintenance jobs and also to check intensities and to talk with production and inspection people to find whether better lighting is needed. Some of the points usually checked are condition of lamps, cleanliness of fixtures, color of furnishings, color and condition of walls.

It is rather a usual condition to discover that a department which was formerly adequately lighted for some semi-automatic operation on small, light-colored equipment has been shifted over to a job which inherently requires better lighting, and that in the shift a lot of large, dark-colored machinery and fixtures have been moved in so that the lighting intensity is perhaps reduced by absorption and obstruction to 50 per cent of what it used to be before the change was made.

District manufacturers rely considerably upon a temporary lighting expedient which the sub-contractor uses to study and experiment with needs and methods of solving the resultant problems. He frequently brings in new lighting sources mounted upon a pole or set of poles which can be fixed temporarily in place in a department. Various types and intensities of lighting are tried out with this equipment. When the answer is found, the actual replacement of fixtures can begin with absolute assurance that they will be right.

HEATING, VENTILATING AIR CONDITIONING

HEATING at Clearing is done principally with oil burners. Most of the equipment consists of rotary type burners which use No. 5 oil.

All boiler capacities are figured by the Standard Practice Code of the Chicago Master Fitters. This code is widely used through the United States and Canada, having been adopted by associations in other territories and incorporated in laws and regulations in many places.

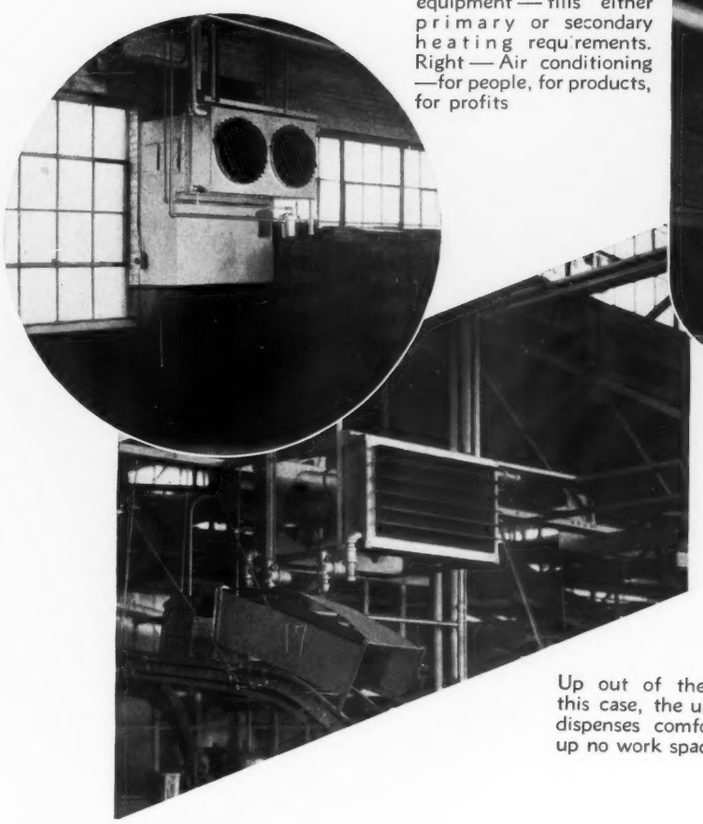
Equipment is installed to care for outside temperatures of 10 deg. below zero F., which is adequate for ordinary Chicago winters. If there comes a day or two of colder outdoor temperature, it is seldom far enough below to cause serious inconvenience. Inside requirements are set by the needs of the plant itself. For the most part, the provision is to yield 70 deg. for office and toilets, 55 deg. in factory space.

The code employed is sufficiently liberal to provide for the ordinary extent of poor maintenance to which heating equipment may expectably be subjected. The engineer is, of course, supposed to keep the boilers and the burners clean. When trouble develops, it is almost always due to lack of cleaning. Experience at Clearing indicates that a surprisingly large proportion of plants pay insufficient attention to this most elementary of heating maintenance practice.

Roof ventilators with wind-direction control are worthy assistants in keeping some jobs clean and safe

With good modern equipment, there is little or no maintenance cost. There are many heating plants in Clearing buildings on which there has been no need for spending a dollar of maintenance cost in the ten or twelve years that they have been operating.

Before the heating season, it is Clearing practice to have a steamfitter go over the place to see that everything is tight, to wash out the plant, to see that all valves are packed. This is the type of inspection and maintenance precaution which prevents emergencies, leaks, freeze-ups, and similar difficulties. It saves money because the preventive work costs far less over a period of many years than does one single rush job of curing a heating-plant ailment which has been permitted to develop until it has reached a really serious stage.



Left—The unit heater—a piece of universal equipment—fills either primary or secondary heating requirements. Right—Air conditioning—for people, for products, for profits

Up out of the way, in this case, the unit heater dispenses comfort, takes up no work space

Without constant prodding, according to Clearing experience, plants individually owned by the manufacturers seldom resort to preventive inspection and maintenance. In fact, such plants are often inclined not even to clean their boilers. The consequence is that service given to such plants is usually hurry-up service for an emergency, and the aggregate cost to the plant is considerably greater than would be the cost of preventive work.

UNIT HEATERS ARE STANDARD

Formerly, Clearing plants were built with pipe coil radiation. This meant a great deal of expensive labor on the job in cutting, threading, and fitting, as well as hanging the coils. More recently, but still a good many years back, Clearing standardized on unit heaters for plant space. This has tremendously reduced installation cost. Two men with chain falls can put in and hang a unit heater of up to 5,000 feet of radiation in a single day. Moreover, the unit heater is adaptable to any problem, will give whatever degree of heat is required and deliver it right where it is needed.

Unit heater maintenance cost is negligible. Motors of the units require regular oiling and inspection. Brushes must be changed occasionally, depending on the operation of the unit. These details ordinarily are cared for by the plant engineer and are almost incidental procedure.

Comparatively little ventilating equipment is in use at Clearing because of the predominance of single-story, monitor type buildings. This type of building is practically self-ventilating, except where process steam is used, or where acid or other noxious fumes must be removed.

Much air-conditioning equipment is installed in various buildings, however, and the percentage of Clearing space which is conditioned is steadily increasing. One plant, making an edible product by a continuous chemical process, has its entire plant conditioned, and in one department controls not only the humidity but also the room temperature to within one quarter of one degree of specified normal.

A plant making confectionery products has air conditioning in two major departments. One of these is a packing department where candy-coated popcorn product is packaged, and where the mechanical equipment would be badly handicapped by the varying degree of stickiness which comes with any considerable change in either temperature or moisture content of the air. The other is in the marshmallow department, where starch molds are used for casting the marshmallows and where a distinct explosion hazard might exist if the moisture content of the air fell below standard.

In both of these plants, of course, the offices are thoroughly air-conditioned. In a number of other offices air conditioning equipment is used or is planned for the immediate future, while some few offices not having provided air conditioning are using room coolers to lower temperatures in summer weather.

Maintenance of air - conditioning equipment has, in Clearing experience, amounted to almost zero. It is, of course, necessary to take care of the motors incorporated in the conditioning units. Beyond this, there is practically no effort or expense. In large systems, properly installed, nothing much seems to go wrong. There is, in such a system, an occasional leak. But these cannot be anticipated and on the rare occasions when they occur call for prompt repair.

PERSONAL SERVICE

PERSONAL service equipment for the employees has proved valuable in most of the plants at Clearing. One of the more modern factories there has rather a complete installation of such equipment, and rather than attempt to cover the entire diversified field in the district, this section will cover the experience of this single plant.

First, rather than install individual lavatories or wash stands this factory uses wash fountains in its locker rooms. They employ a great deal less space than would more conventional washup equipment. In the men's locker room, for example, one wash fountain is adequate (the plant employs chiefly girls). To provide adequate washup facilities for the men, at least fifteen or eighteen individual lavatories would be needed, and they would take up two full walls or make a double row running the entire length of the room.

By the nature of its design, the wash fountain is sanitary, since the workers use only running water which comes

Sanitary—Running wash water and unused towels, showers after dirty jobs. Satisfied workers, little expense for doctors

out of small shower-head outlets. It never gets dirty because it is self-cleaning, as is a shower bath. Water consumption is materially lower.

The janitor in charge of this section of the plant cleans up the wash fountain daily, a five-minute job. The soap-dispenser is mounted in the middle in plain view, and the janitor periodically pours in liquid soap as needed. There is practically no piperun for the soap, which means just so much less opportunity for soap caking and clogging the outlets. About four times a year the dispenser is allowed to run almost dry, then soap is run out of it on a Saturday when the plant is not working, the container is washed, hot water is run through the outlets to clear them, and a wire is run through the opening to take off any caked soap.

FOR MEN, SHOWERS

Showers are not provided for women, who are all on light work. Showers are provided, however, in the men's locker room. The prime reason for the showers is to serve the machine maintenance men and others who have heavy and comparatively dirty occupations. Soap and towels are provided, and most showers are taken on the men's own time. The exception is when a man gets into a particularly dirty job that leaves him unfit for work in the plant; then he gets a shower on company time. For example, boiler flues are cleaned once a month, and as soon as a man finishes this job he gets a clean suit of overalls and takes a shower.

In winter, perhaps 10 per cent of the men use the showers. In summer, the figure runs above 70 per cent. Showers are cleaned daily by the janitor, shower curtains are laundered weekly. As yet the showers have required no maintenance or repairs.

Toilets are cleaned down every two weeks, on Saturday when the plant is shut down. The bowls are cleaned with chemical cleaner, and on Saturday it is possible to leave the chemical in the bowls for several hours to get the full benefit of its action.

Electric driers are provided in washrooms, as well as towels. Most of the employees seem to wipe their hands on towels, then finish off with the drier. Motors are taken from driers once a year, thoroughly oiled and cleaned and replaced. There has been no other maintenance needed.

Electrically refrigerated drinking fountains are spotted through the plant where convenient to the largest number of employees. They are cleaned daily by the porters, which is not strictly necessary but is in tone with the unusual standard of cleanliness maintained throughout this plant. These fountains have been used continuously for four years, and so far the total maintenance expense has been replacing one fuller ball. The motors are sealed, and there has been no motor maintenance work.

Steel lockers are standard throughout this plant because they are vermin proof, substantial, and look good. Some of these lockers are twelve years old, having been moved over when the new plant was erected. There are many newer lockers, added at the time of the move into the present quarters.

On the older lockers, there has been some slight trouble with locks, chiefly because they have become dirty and oil-clogged. This trouble is handled by keeping on hand at all times several locks from lockers which have been scrapped. When a lock gives trouble, a plant maintenance man goes to it, removes the troublesome lock, replaces it with an old lock in perfect order. Then he cleans the lock he has removed, puts it back, and holds the spare.

General experience with the newer lockers suggests that lock trouble will not be encountered when they are equally old. They seem to be better constructed, less liable to trouble than the old ones were when they had been in service the same length of time. In any event, this trouble amounts to a good deal less than the telling would indicate. It arises, in some hundreds of lockers, not more than once or twice a month, and takes only a few minutes of the maintenance man's time to overcome and straighten out to the satisfaction of all concerned.

ASSORTED MAINTENANCE JOBS

When the slack season approaches, foremen and other key men and women are formally notified of the fact and are instructed to begin making notes of maintenance of all kinds, no matter how small, which would be helpful. Also of any improvements which would be helpful to the plant. By the beginning of the slack season, a sizable list has been accumulated and most of the major suggestions have been O.K.'d for going ahead. Thus, as work slackens, those people best fitted to perform these assorted odd jobs of maintenance and improvement are assigned to them, leaving the less adaptable employees to continue with the lessened volume of production.

Whenever any subsequent maintenance need comes to the management's attention, even though it is merely a small painting job which at the fix-up season had been a small flaking, the key man within whose responsibility it properly falls is reminded that, if he had been on the job, this would have been taken care of in the slack season at no cost to the company or to the bettered earnings of the plant personnel directly concerned.

PROTECTION

A MAJOR influence upon fire protection is, of course, the structure itself. So much has been written and said on this subject that it need not be covered in this section. However, one precaution is especially worth mentioning because it comes up in the field of alterations. Clearing Industrial District experience indicates that the cost of a clay tile or gypsum partition is so little if any more than the cost of wood or wood and chicken-wire that it is wise to use these fire-resistant materials to retard any internal fires.

Inspection at Clearing regularly provides for finding any obvious fire hazards which exist. However, to a man not especially trained in this field, a great many hazards are not noticeable, and therefore the district relies heavily upon the inspection of the fire insurance companies covering their buildings. Fire insurance companies are willing and eager to be of all possible assistance in reducing hazards. It is to their direct interest; therefore, it is always possible and advisable to call upon the inspection bureau of the in-

suring companies, either direct or through the agents. This is particularly advisable whenever there is any change in connection with the fire hazards through changes of process or occupancy, or of protective equipment.

The annual bulletin issued by one group of factory insurance companies is good advice in any manufacturing plant and well worth following.

CARE OF SPRINKLERS

Where either the structure or objects housed, or both, are combustible, it is advisable and economical to have sprinkler protection. Inspection of sprinkler systems is probably best left to insurance inspectors. However, when repairs or alterations have made work upon the sprinkler system necessary, certain precautions and tests can well be employed.

In dry pipe systems, usually found in unheated areas, certain things require periodic check-up. Pitch of pipes is one; water accumulates at low points and, in cold weather, if it does not burst the pipe, obstructs it and shuts off or reduces the flow of water when needed. This should be checked by plant mechanics before the arrival of freezing weather.

Air pressure must be right in the dry-pipe section—this varies with the system. Controlling valves must be in working order and wide open, water must be right up to the dry-pipe valve. Insurance company tests are standardized to check drain; air pressure; priming water; water pressure; alarm; location of dry-pipe valve (in a heated location).

On wet systems, inspect for water pressure by making a drain test. Some systems have an alarm with some sort of flow mechanism; these are tested by making a flow through it. Also, it is advisable to drain toward the end of the system to see that there is water up to the end of the system. In brief, make sure that the pipes are clear and have water throughout.

Stocking of goods and installation of equipment should always be done with full recognition of the need to leave unobstructed the water distribution from sprinkler heads. Violation of this obvious precaution is one of the most frequent sins against a sprinkler protective system.

Fire alarms are usually tested regularly by the maker of the alarm, under a maintenance contract. Where such tests are not provided for, the plant mechanics should regularly test the circuit and occasionally test the alarm boxes.

TO TEST EXTINGUISHERS

Extinguishers vary from water pails and sand pails through various forms, some of which can be frozen and others of which are non-freezing. A simple test for extinguishers is to lift them to see whether they are full. Look into the end of the hose to see if it is plugged up, or better yet run a wire up it. You may have a pressure burst in the extinguisher if you try to use it and it is plugged up or has been frozen. See that extinguishers are recharged at proper intervals, recharging according to instructions from the fire insurance inspector. Extinguishers should be inspected at the time of recharging.

For hydrants and hose inside the buildings, see that the hose is in good condition and hung up so it will come away when needed. Hose is often so hung that when an excited employee attempts to pull it off the rack, it gets so snarled that untangling it takes minutes just at the moment when it may stop a fire from becoming really serious and spreading.

HOSE AND HYDRANTS

Outside apparatus, consisting chiefly of hose and hydrants, needs inspection similar to inside hose; likewise, hose houses should be checked to make sure that wrenches, spanners, nozzles, and so forth, are all at hand. There should also be extra hose and an extra nozzle, both in good condition. When making summer tests of water and hydrants put occasional pressure tests on the hose and nozzles to make sure they measure up to requirements. In winter, test to see that hydrants drain properly to prevent freezing.

Where flammable material is stored outside, it should be securely protected with manproof fence. Otherwise somebody is likely to curl up in your pulpwood or your tanbark or your cotton bales for a cozy smoke, and eventually set fire to your factory or mill. Fire protection is equally important with theft and burglary hazards in considering the usefulness of a fence.

Except for a very few of the smaller plants, every Clearing plant has its own interior watchmen. The Clearing Association takes care of all outside police protection, with four radio-equipped squad cars on 24-hour duty. The small firms which dispense with watchman service are able to do so because anyone entering the district during inactive hours is almost surely seen by the police. Even a load of kindling cannot get out without a permit.

Fire pumps should pick up suction promptly. On steam pumps, fire insurance inspectors usually operate up to top pressure of the relief valve, then hold the pressure at about 80 pounds and count the strokes. If too many strokes, it is disclosed as faulty. On summer tests, try them up to rated capacity or higher. For centrifugal pumps, specialized tests are required in experienced hands. For electrically driven pumps, see that the electrical supply is well arranged, reliable, and not liable to interruption by the very fire it is needed to fight. Where unavoidable exposure hazards exist for the electrical supply, it is often worth while to shift over to gasoline power.

TANK INSPECTIONS

Precautions about tank footings and anchorage have been treated elsewhere in this supplement. On tank inspection, make sure that valves are open, the tanks full; in cold weather see that they are adequately heated. Not too much heat, however; in wooden tanks it rots the tank, in steel tanks it is a waste of money. Leakage not only interferes with water supply but also an ice load may crash a tank tower, which is designed for no such stress. Keep steel surfaces painted, or scrape and repaint. Tank failure is inherently dangerous, as well as constituting an objectionable fire hazard.

Protected—As benefit of fencing, fire prevention is equally important with protection against theft and burglary

Guides to BUILDING MAINTENANCE

Features of Composition or Built-Up Roofs*

1. Width of felts used	30 to 36 inches
2. Materials of felt	Rag stock, or asbestos fiber
3. Impregnation of felts	Coal tar pitch, asphalt
4. Mopping between and over felts	Coal tar pitch, asphalt
5. Weight of felts	14 to 15 lb. per 100 sq.ft. is most common, but they are made in other weights up to 40 lb. per 100 sq.ft.
6. Number of plies	Cheapest roofs are two and three ply. Five plies usually used for 20-year roofs
7. Finished surface	Gravel imbedded in pitch or asphalt Slag imbedded in pitch or asphalt Special, mineral-surfaced cap sheet, and other special cap sheets Smooth coating of asphalt
8. Total weight per square foot	Smooth-surfaced roofing: 1½ to 2½ lb.; slag-surfaced, 5 to 6 lb.; travel-surfaced 6 to 7 lb.
9. Range of costs	7 to 12 cents per sq.ft. in place, without flashings

*This type of roof is suitable for flat or sloping roof decks, subject to the following limitations: Gravel surfacing should not be used on slopes exceeding 2 inches in 12. Coal tar pitch should not be used on steep slopes. Asphalt with slag surfacing can be used on slopes up to 6 inches in 12.

Painting Defects

	Surface	Defects on Surfaces		Reason for Defects		Remedy for Defects		Preparation of Surface	
		New	Old	New	Old	New	Old	New	Old
Exterior Surfaces	STEEL	Oil or grease, mill scale	Peeling of paint; rust and scaling of metal; oil or grease	Manufacturing process	Oxidation of metal due to poor painting; loosening of mill scale; negligence in painting		Paint properly, without delay, when necessary	Clean off dirt. Remove oil and grease with benzine. Remove mill scale on plates by sandblasting, or allow to weather 6 mo. then sandblast	Thoroughly chip, wirebrush, or sandblast
	WOOD	Dampness. Dirt spots	Blistering, peeling, wrinkling		Dampness, poor paint used, improperly applied, or too long period between applications	Allow to dry thoroughly. Bleach with oxalic acid	Do not paint damp surfaces. Paint more often. Use proper paint	Clean off dirt	Scrape and clean. Burn off old paint if surface is wrinkled
	CONCRETE	Porosity of surface, allowing dampness to attack steel reinforcement	Peeling of paint, absorption of moisture	Inherent nature of concrete	Surface not thoroughly dry when painted: waterproof paint has not withstood elements: insufficient paint applied	Waterproof surface	Properly waterproof surface	Clean and wirebrush entire surface, "V" out cracks and caulk with asphalt-base caulking compound, caulk around all window sash. Do not paint until surface has aged 1 year	Clean surface, caulk all cracks and around window sash where needed; apply 1 coat of prime paint over bad areas
	BRICK *							Same as for concrete surfaces. Where necessary point all joints with mortar.	
	GALVANIZED SHEET METAL	Oil and grease. Acid	Same as for steel	Due to galvanizing	Same as for steel		Same as for steel	Wash with vinegar or copper sulphate solution	Same as for steel
Interior Surfaces	STEEL	Same as for exterior steel	Same as for exterior steel		Same as for exterior steel		Same as for exterior steel	Same as for exterior steel	Same as for exterior steel
	WOOD †								
	CONCRETE	Small holes; dampness	Blisters, peeling of paint; discoloration and oil spots	Lack of proper tamping when concrete was placed	Surface damp when painted; action of alkali in concrete on oil in paint; paint applied over improperly prepared surface; oxidation of oil in paint; spattering of oil from machinery		Do not paint on wet or damp surfaces. If oil paint is to be used allow surface to dry at least 6 months	Fill holes with paint or plaster and point cracks. Clean off dirt	Clean surface thoroughly, apply aluminum paint or shellac to oil spots, scrape off all loose paint; coat all bare spots with primer paint
	BRICK **							Also point joints with cement mortar	
	PLASTER	Dampness	Same as for concrete	Not dried out	Same as for concrete	Same as for concrete	If oil paint is to be used allow surface to dry at least 2 months	Point cracks, clean off dirt	Same as for concrete
	CONCRETE FLOORS	Dampness	Paint surface worn through		Natural wear and tear	Do not apply any coating on floor until it has dried thoroughly	Use penetrating oils and not merely surface coatings	Sweep and clean surface. Allow to dry thoroughly before application of paint or filler	
	WOOD FLOORS	Warping, dirt spots	Paint surface worn through	Dampness	Natural wear and tear	Keep floor dry. If placed over concrete allow concrete to dry out and coat with asphalt or tar compound before laying		Clean off dirt	

Note: *New* indicates surfaces not previously painted. *Old* indicates surfaces previously painted.
*Brick walls should be waterproofed to preserve surface and improve appearance. † Same as for exterior wood surfaces. ** Same as for concrete surfaces.

Roofing Materials That Combine Deck Construction and Waterproof Covering*

Material	Usual Size of Sheets	Weight per Sq.Ft. of Roof, Lb.	Usual Spacing of Supports (Purlings)	Minimum Roof Slope, Inches	Approx. Cost, Cents per Sq.Ft., in Place	Remarks
1. Corrugated iron, black or galvanized	Widths 27½ in. and up. Lengths to 12 ft.	1 to 2.25	5 to 7 ft.	4 in 12	11 to 21	20 or 22 gage recommended. Cost of copper-bearing steel and special irons is slightly higher than shown.
2. Corrugated, asbestos-protected metal	33 in. wide. Lengths up to 12 ft.	1.75 to 2.50	4 ft. 9 in. to 8 ft.	2 in 12	21 to 26	24, 22, and 20 gage. Lap joints laid in elastic cement. Obtainable coated with copper or aluminum foil, at added cost of 4c per sq.ft.
3. Corrugated sheets, portland cement and asbestos fiber.	Widths 27 and 42 in. Lengths up to 11 ft.	4.75 to 5.50	4 ft. 6 in.	2 in 12	18 to 25	$\frac{7}{16}$ in. thick at top and bottom of corrugations, $\frac{5}{16}$ in. on curves. Lap joints laid in elastic cement.
4. Interlocking cement tile	24x52in.	14 to 16	4 ft.	4 in 12	30 to 33	Tiles with glass inserts 19x31 in., $2.50 per tile extra.
5. Cast-iron plates	24x52 in. $\frac{3}{16}$ in. thick.	11 to 11.5	4 ft.	4 in 12	42 to 45	Laid with separate cover plates over side joints.

**To be used on sloping roofs only. Suitable for foundries and similar buildings where rapid heat loss through roof is not serious. Should not be used over rooms having high humidity, on account of condensation.*

and Remedies

° Prime Coat °		° Second Coat °		° Finish Coat °	
New	Old	New	Old	New	Old
Red lead and linseed oil; red lead, graphite; red lead, red oxide; blue lead; coal tar base paints	Where steel is exposed, cover with prime paints as for new surfaces	Same as prime, but reduce pigment content	Not needed unless old paint has deteriorated badly	Same as second coat; coal tar base paint; aluminum paint	Same as for new surfaces
White lead or zinc and linseed oil, linseed oil, wood stain	Spot paint with prime paints shown for new surfaces	White lead or zinc and linseed oil. Stain	Usually not needed. Same as for new	White lead, and/or zinc and linseed oil. Varnish	Same as for new
Apply thin coat of wax-base, waterproof paint, or chemically compounded waterproof paint—colored if desired	Same as for new	Same as for prime coat	Generally not needed unless surface is in poor condition	Apply heavier coat of same paint as used for prime coat. If uniform finish is not obtained, apply additional coat of finish to dead areas	Same as for new
Same as for concrete	Same as for concrete	Generally not needed	Generally not needed	Same as for concrete	Same as for concrete
Same as for steel, but applied before erection		Same as for steel	Same as for steel	Same as for steel	Same as for steel
Same as for exterior steel except pigment content of paint may be reduced	Same as for exterior steel and reduce pigment content	Generally not needed	Generally not needed	Same as for exterior steel	Same as for exterior steel
Coat with oil mill white primer or casein-base paint	Mill white prime paint, casein-base paint, or aluminum paint. If surface had been previously painted with cold water paint, add additional linseed oil to prime paint, or coat surface with oil and turpentine for casein-base paint			Oil mill white using flat, eggshell or gloss finish as desired. Casein base paint if needed	Same as for new
Same as for concrete	Same as for concrete	Same as for concrete	Same as for concrete	Same as for concrete	Same as for concrete
Penetrating oils and gums mixed with solvent and colored as desired. Primer for floor paint		Same as prime coat		If oils and gums are used, apply 3 coats floor paint	Same as for new
Hot linseed oil; shellac, wood primer for floor paint; wood filler	Same as for new	Hot linseed oil; shellac; stain	Same as for new, if needed	Hot linseed oil; shellac, floor paint; varnish	Same as for new

Prepared by **L. E. DRIVER** *as a part of the chapter "Painting," see page S25*

Prepared or Roll Roofing**

1. Usual width of sheets, 36 inches
2. Common weight of sheets, 35 to 75 lb. per 100 sq.ft.
3. Costs in place per square foot, 2¼ to 3¾ cents

***Applied in one thickness, usually with 2-in. lap cemented. Should be used only on slopes of 4 inches in 12 or steeper. Suitable for sheds, temporary buildings, and like structures.*

Compilations on these pages were made by L. E. DRIVER, Chief Engineer, New York Dock Company, New York (Painting) and S. B. LINCOLN, Vice-President, Lockwood Greene Engineers, Inc., New York (Roofs)

Types of Floors for Industrial Buildings

Description	Approx. Cost Per Sq.Ft., Dollars	Remarks
Stone concrete, 6-in. reinforced (ave. 1:2:4) (on ground)	0.20 to 0.25	Good for storage areas and ordinary wear. Usually on first floors or for integral part of building itself.
½- or 1-in. grit-top, special finish on stone or cinder-concrete base	0.15 to 0.20	Usually quick-finish process with machines. Very durable, hard, smooth. Treated metal filings add to surface life. Should be on solid base; structural cracks extend to surface. Good for many types of heavy manufacture and use.
Asphalt compositions (poured) about 1½ in. thick on concrete, brick, or solid wood base	0.40 to 0.60	Usually for protection from acids, etc., and waterproofing of areas. Quiet and clean. Not good for very heavy trucking operations. Surface tough, but not so hard as concrete.
Protection of concrete by treatment or painting (about 3 coats)	0.02 to 0.06	Various media to suit specific needs. If structure of floor is cracked they will not make it waterproof. Keep down dust; many add to wearing quality of surface. Usually require 2 to 4 thin coats for good penetration. Paints require frequent renewal, but add to appearance. Concrete top can be mixed with ochres or other pigments for permanent color.
Tiles, linoleums	0.20 to 0.30	Usually for offices; are stuck to floor or set in mastic on concrete, brick, or wood. Appearance very good. Too frail for heavy manufacture. Usually quiet and clean.
Soft woods, 1¼ in. thick	0.15	Long leaf yellow pine, spruce, etc. Can be placed directly on floor beams. Not good wearing surface for trucking, but satisfactory for storage and like areas. Quiet, clean, healthful.
Hard woods, ⅞ in. thick	0.15	Oak or maple; good to surface over old wood floors in offices and light manufacturing areas. Set in mastic on concrete. Must be kept dry.
Hard woods, 1¼ in. thick	0.20	Oak and maple. Can be set directly on beams. Must be kept dry. Good for light and moderately heavy manufacture. Will not stand heavy trucking. Clean, dry, fairly quiet.
Wood block, 1- to 2-in. (grain vertical)	0.25 to 0.40	Best wearing of wooden floors under trucking. Should be kept dry even if treated. Quiet, clean, healthful. Can be set on concrete, brick, or wood base.
Steel plates, 3/16- to ¼-in. on wood floors	0.25 to 0.30	Can be installed while plant is operating. Very long life if properly fastened. Slippery under water, oil, dry dust.
Hard-burned brick, on edge	0.25 to 0.35	Very noisy under iron wheels. Good in aisles and at points of heavy traffic. Long life. Requires structural base. Little dust from wear.

Light Reflecting Value of Colored Paints

Color	Per Cent of Light Reflected
White, new	82-89
Cream	73-78
Ivory	62-80
Buff	61-75
Aluminum	65
Light green	49-66
Yellow	48-75
Gray	36-61
Light blue	34-61
Pink	30-46
Dark tan	17-63
Dark red	13-30
Dark green	11-25
Light wood varnish	42-49
Natural wood, stain	17-29

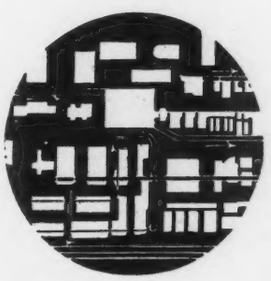
Information on this page compiled by G. W. BORDEN, Construction Engineer, New York Dock Company, New York

Points to Check in Piping System

Item	Check for
Meters	Accuracy, broken dials, hands, seals, leaks, supports, and need for protection to prevent freezing.
Bypasses	Painting, leaks, valve packing, supports.
Control valves	Packing, condition of valve seats, leaks at connections.
Risers	Painting, leaks, condition of floor clamps, hangers, expansion joints, sleeves and curbs, guards, covering.
Soil and vent stacks	Painting, leaks, condition of floor clamps, hangers, sleeves and curbs, guards.
Mains	Painting, leaks, slope, condition of hangers, wall sleeves, expansion joints, covering.
Horizontal runs	Painting, leaks, slope, condition of hangers, sleeves.
Branches	Painting, leaks, slope, condition of hangers, sleeves, covering guards.
Hangers	Fastening, adjustment for slope of pipe, proper spacing and strength, covering on lines at their location, painting.
Covering	Painting, need for canvas or metal protection, sewing or bands' looseness, holes, general adequacy.
Expansion joints	Painting, possible covering, leaks, packing, alignment, anchorage or supports.
Sleeves and curbs	Stability, packing around pipes, height of sleeve top or curb above floor, pointing at exterior of sleeves in floors to prevent leaks.
Hand valves	Possible covering, condition of seats, packing, wheels, stems, presence of leaks, cracks in body.
Toilet flush valves	Pipe sizes, leaks, need for adjustment.
Traps and seals	Painting, possible covering, leaks, cracks, stoppage, supports.
Fixtures	Cleanliness, cracks, fastenings, leaks at connections.
Sprinkler heads	Cleanliness of fuse, melting points of fuses near heaters or hot pipes, correct number and location, protection from damage or freezing, need for painting of body.
Radiators	Painting, leaks, slope, condition of hangers and supports.
Heaters	Cleanliness, condition of fins, motors and wiring, hangers, presence of leaks.
Air valves	Leaks, need for cleaning, proper size, number and location.
Swing check valves	Leaks, proper size and location, cracks in body, condition of seats.
Traps	Painting, leaks, internal cleanliness, condition of seats, coils, etc.
Thermostats	Proper temperature ranges, fastening, proper location, need for protection from damage, condition of connections.

PLANT LAYOUT

AUTHOR
ALLAN H. MOGENSEN
Consulting Editor



FIFTEENTH IN THE SERIES OF

FACTORY MANAGEMENT and MAINTENANCE

PLANT OPERATION LIBRARY

CHAPTER ONE

Product vs. Process Control

1936 has brought many new problems. In general, business activity has been greatly increased. It is no wonder, then, that many executives were surprised and disappointed when they found that their operating figures did not show earnings commensurate with this increase in business. In many instances the picture was even worse than for the previous six months. It is not easy to change from a depression to a production basis and keep costs in line.

It is evident, then, that the search for continually lower costs must go on. Because of this search, and also due to necessary expansion of production facilities, plant layout has become an increasingly important phase of plant operation with a universal appeal to plant operating men in every branch of the manufacturing industries.

Changes in layout range all the way from slight revisions and rearrangements of departments to complete remodeling in order to bring machine layout into line with modern practice. Some few concerns have found their present buildings inadequate and have built new plants.

CONTINUOUS OR INTERMITTENT?

In general, manufacturing industries can be divided into two groups, continuous and intermittent. In plants operating on the continuous basis the raw material flows consecutively through a series of machines or processes that are set up to operate as one complete unit. These continuous processes may take a natural product, such as salt, oil, lumber, or mineral ore and transform it into finished products. An analytical process will result in several finished products — a petroleum refinery, for example, converting crude oil into gasoline, kerosene, benzine and other products. By means of a synthetic process it may take some of these same natural products and build them up into such things as rayon, celluloid, artificial leather, paper, or cement.

Plants like these are in most instances laid out along the line of the chemical flow chart (Figure 1) for the production of viscose rayon. It is evident, of course, that the process itself will have a great deal to do with the design and layout of the plant, inasmuch as the raw materials pass in at one end of the plant, flow through a number of given processes, and emerge at the other end as finished products and byproducts.

The other type of industry, based on the intermittent process, is not so simple. Such a plant may use many raw materials instead of just a few, and may often take as its raw materials the finished products of other plants. In such plants there is a continual change occurring which may in itself change the nature of the operation. For example, the automobile plant of 1904 was quite similar to the jobbing shop of today. Then, in the search for better methods and lower costs, specialization to a high degree took place until today we have in more than one automobile plant a layout quite similar to that of a continuous process industry.

FOR INSTANCE, PLYMOUTH

Such a plant layout, that of the Plymouth plant, is shown in Figure 2. The lines of flow, as indicated by the strings on the layout board, are indicated for one year's model, and are not ordinarily changed during the run of that model.

Not all plants can be classified into one of these two extremes. The majority of factories fall somewhere in between, having in some departments a simple, continuous flow, and in others, by necessity, the intermittent type. A good illustration is that of a plant making a variety of small metal products and performing various operations, such as punch press, screw machine, and die casting. All these parts go to a plating department, where they flow through a continuous process of washing, rinsing, and plating, all on an automatic conveyor, and then come out to break up and scatter to various parts of the plant in intermittent fashion.

As plants grew in size, most of them naturally went to departmentalization by process, because most processes were built up around the individual. This method of production depended upon specialization in one type of process, and was for years the generally accepted method of manufacture. It seemed the logical one because it gave the greatest amount of production for the least capital investment in equipment and allowed the development of specialists among the workers themselves, thus resulting in high efficiency and low labor cost.

In plants set up this way, several or many products were moved through the various process points. There would be a general rough machining department, a general punch press department, a general screw machine department, a general buffing and plating department, and an assembly department. The various products then moved in and out of these departments, usually passing through stockrooms and inspection departments at each step. All this involved planning, routing, scheduling, and dispatching, with much red tape and clerical effort, but with little real system.

Coupled with the natural growth that resulted in the process method of manufacture was the emphasis placed upon its efficiency by the early pioneers in the field of scientific management. Frederick W. Taylor and his associates constantly stressed the importance of specialization and completely centralized control. In fact, many people mistook for scientific management the elaborate systems of planning and production control often set up to handle the flow of work.

ENTER MECHANICAL HANDLING

As the transportation problem became serious, mechanical handling was developed to replace trucking, hauling, lifting, and carrying. In many instances conveyors were installed without changing the location of machines

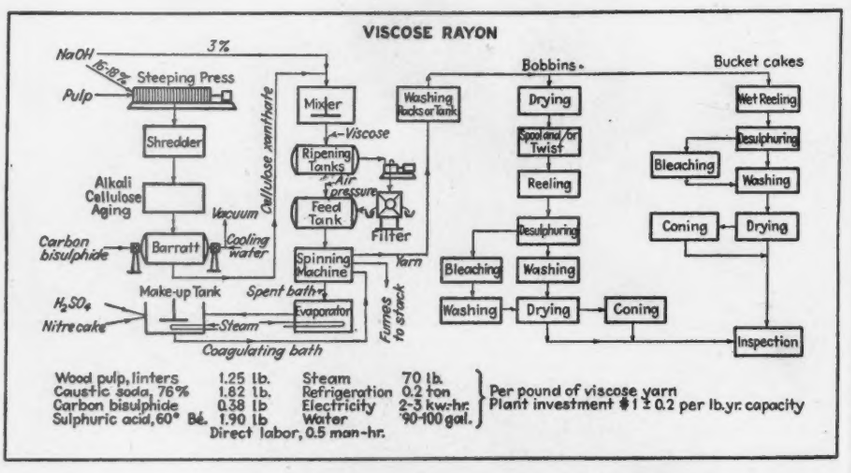


FIGURE 1. Chemical flow chart for production of viscose rayon. Process has much to do with design and layout of plant

FIGURE 2. Automotive layouts of 1904 were much like what you would expect to find in jobbing plants. Today more than one is laid out like a continuous process industry. For example, the Plymouth plant

at all. Such an installation is shown in Figure 3, where the conveyor is located in the center of the aisle formerly used for trucking.

The other type of control is control by product, which really sets up within the plant small factories, each one making a certain product. One might say that it enables the setting up of small continuous industries in a plant formerly operating on an intermittent basis.

Main argument in favor of the process or functional method is that both workers and supervisors become experts in their line of work. Repetition of one or a few operations naturally tends to increase efficiency. In addition, the number of machines required to handle a given production is considerably less than it would be were each one of the parts produced in a separate department set up on a product control basis. This is evident because it is easier to keep a group of similar machines in operation and under full scheduled load than to do so where each machine is the only one in a group of widely varying operations. Such items as maintenance and repair, spare machines and parts, physical layout within the department, and power transmission are much simpler to handle.

HIGH COST OF TRANSPORT

Oftentimes so much emphasis was placed upon some of these economies that we entirely overlooked the high cost of transporting parts from one department to another, which resulted in low turnover and big investment in raw materials and work in process.

Another thing, when work is transported from one department to another, and each department is under different supervision, there is introduced the need for weighing, counting, and inspection—all of which add no real value to the product. Likewise, there is the increase in cost of overhead because many of the foremen and supervisors become little more than clerks engaged in handling the huge volume of paperwork needed to control factory production.

On the other hand, the plant set up for product control finds many advantages. First, simplification of handling. The answer to any handling problem is always to eliminate it entirely if possible. Although this is not always practicable, one of the startling improvements usually discovered in going to this type of production is the reduction in distance traveled by the various parts.

However, if it is necessary to handle, it can usually be done by mechanical means with simplified scheduling and lower cost. Also, when the entire operation is under the jurisdiction of one man, who is in effect the general manager of a little plant, he can make his various foremen, or even operators, responsible for quality, and thus eliminate the unnecessary inspections, weighings, and handlings between departments. Often a group incentive plan of wage payment can be installed. Clerical work is greatly reduced; raw material, work in process, and finished parts are minimized. Increased turnover is probably one of the biggest advantages of the product method of control, because industry in general is still buying pretty much from hand to mouth, and immediate deliveries are usually asked for.

It is difficult to discuss plant layout in terms of pure product or process control. We do not often have simply the one or the other. In most plants we have a combination of the two. For example, there are not many plants that can justify five or six complete plating or heat-treating units. Nevertheless much has been done in the way of setting up complete units for washing and spray-painting — operations that for a long time we thought it necessary to handle in one place alone.

TRUCKING ELIMINATED

New and more effective equipment has often made it possible to break up certain departments and scatter the equipment at strategic points throughout the plant, thus eliminating the trucking of all the work to the one department. Such an example may be found in Figure 5, where a small household vacuum cleaner has been applied to a grinding or buffing wheel. In the past it was thought necessary to have these operations centralized in one room in order to connect all the wheels to a common exhaust system. Use of equipment such as this has made it possible to locate these units right next to the preceding or succeeding operations, and thus eliminate transportation between departments.

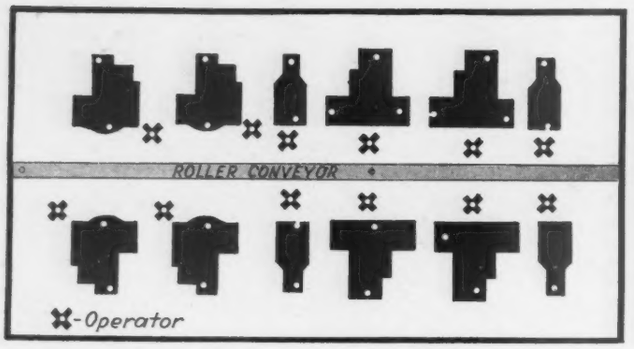


FIGURE 3. This conveyor was installed in the center of the aisle without moving a machine

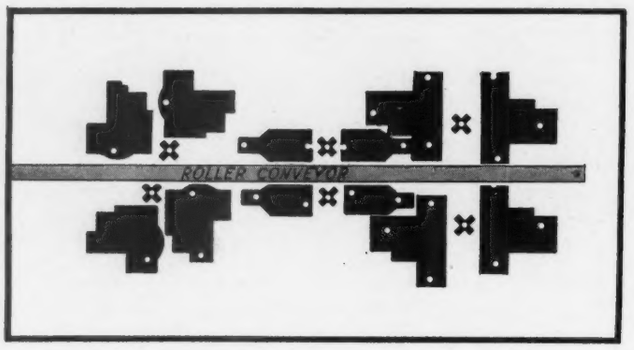


FIGURE 4. Same conveyor, same machines, but now six operators do the work of twelve

The extent to which any plant can move in one direction or the other is necessarily limited by the nature of its manufacturing problems, but there is no doubt that a fair and open-minded analysis of the situation with the question asked, "What would our picture be if we went to the other extreme?" will often lead to a more nearly correct middle position.

SIX DO WORK OF TWELVE

Consideration of this problem led the plant with the layout shown in Figure 3 to change it to the one shown in Figure 4. Although this is a simple illustration, it emphasizes the basic idea. Now, instead of twelve operators, six can produce the work with no more effort. Walking time has been eliminated, turning around for stock done away with, and idle machine time utilized.

As a result of this sort of thinking, changes were made in the whole plant layout. Floor space was cut 40 per cent. Manufacturing costs were reduced. Investment in machines and stock containers dropped several thousand dollars in one department alone. Where machines could not be located to permit combination of several cycles, chutes were used between operations. In one instance, a milling machine and two drill presses were grouped together for operation by one man, thus eliminating walking time, turning around for stock, walking over to the stock container, securing the work, taking it back to the machine, and then putting it back again when the operation was completed, for each one of the three machines.

In another concern, rearrangement was recently made along the same lines. Despite the variety of equipment manufactured in this department, it was found possible to group the work, and thus the equipment, into four major areas. The first step was to make flow process charts for each part, recording each operation, the type of equipment, and the distance traveled in feet, as well as the means of conveyance.

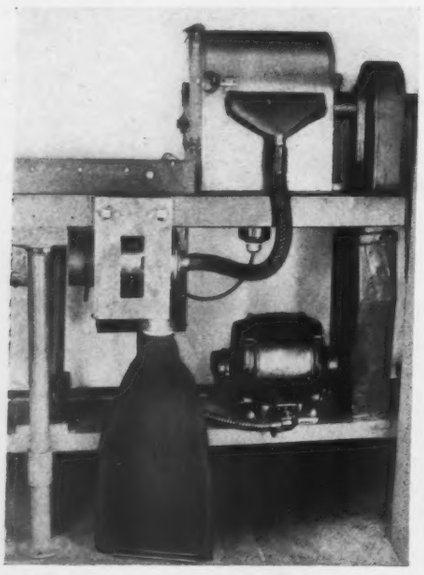
A study was then made of each operation to see if a better way could not be found to do the work. When the new layout was under way, various arrangements were tried out on the drawing board until one was found that seemed to possess the greatest possibilities for satisfactory operation. Careful consideration was given to the method of handling, as well as to the relative arrangement of the various machines for the most efficient set of motions. Each plan was then discussed with the job foreman, the department superintendent, and the supervisor of stock and production, thus securing the benefit of the factory men's thinking.

The new layout has reduced the distance traveled in manufacturing an electric motor by 35 per cent, which in terms of normal production means an annual saving of 13,200 miles per year. Departmental floor space was reduced 11 per cent; floor area, 44 per cent. Inventory of work and materials in process was reduced 10 per cent; overall time required to build a motor, 20 per cent.

FROM 43 DAYS TO 5½

Another concern, by changing from process to product control, was able to reduce manufacturing intervals from 43 to 5½ days. Still another, whose product is subject to fluctuating consumer demands, was able to cut down time from 5 to 1½ days, and one metal-working equipment plant has reduced time from three months to as many weeks. Another manufacturer, building special equipment, told me recently that by utilizing some of these principles he has been able to turn out a machine in 10 days that only a year ago took several months to make.

FIGURE 5. Small vacuum cleaner makes it unnecessary to truck the work to a central grinding department and back again



CHAPTER TWO

Process Chart as Layout Tool

THE ENGINEERING approach to any problem is to analyze the present method. There is no better tool for this analysis of present layout than the flow process chart originated by Frank B. Gilbreth. This chart is made by following a part or a product through all steps from the very first one until it leaves the plant. The chart subdivides all the things that happen to this part into operations, transportations, storages, and inspections—which are denoted by symbols. While Gilbreth developed many more than the five shown at the bottom of Figure 7, they cover the range of practically all shop operations and simplify chart making and reading. Wherever a move or a handling of any sort occurs, the distance traveled is shown and sum-

PROCESS FLOW CHART
MODEL 33 RECEIVER
OLD LAYOUT

TRAVEL: (Feet)	OPERATION:	DESCRIPTION:
	▽	Raw stores
	(1)	Load on truck
655	(K)	To dept. 77
	(2)	Blank and pierce
27	(M)	To press
	(3)	Pierce 2 locating holes
24	(M)	To press
	(4)	First form
14	(M)	To press
	(5)	Second form
6	(M)	To press
	(6)	Finish form
20	(H)	To elevator 43-1
15	(E)	Up one floor
19	(H)	To wash
	(7)	Wash
57	(H)	To elevator
15	(E)	Up one floor
	▽	Wait for electric truck
1015	(K)	To dept. 75
	(8)	Drill and assemble inserts
4	(M)	To floor
64	(M)	To riveting machine
	(9)	Rivet inserts
223	(H)	To bench
	(10)	Burr rivets and rear end
214	(H)	To handscrew machine
	(11)	C-bore and face front end
173	(H)	To wash room
	(12)	Wash
125	(M)	To drill
	(13)	Drill 3 holes
125	(H)	To wash
	(14)	Wash
64	(H)	To powermill
	(15)	Powermill loading opening
72	(H)	To wash
	(16)	Wash
211	(H)	To handmill
	(17)	Handmill recoil slot
93	(H)	To press
	(18)	Shave bolt lug slot
82	(M)	To profile
	(19)	Profile bolt slot
174	(H)	To wash
	(20)	Wash
335	(H)	To bench
	(21)	Finish file
251	(H)	To tapping machine
	(22)	Tap front end
66	(H)	To wash
	(23)	Wash
343	(H)	To bench
	[24]	Inspect
105	(K)	To elevator
15	(E)	Up one floor
172	(K)	To elevator
15	(E)	Up one floor
600	(K)	To polishing
	(25)	Polish outside
200	(H)	To bench
	(26)	Finish file
307	(K)	To bench
	[27]	Inspect
935	(K)	To dept. 52
	(28)	Brown
171	(H)	To bench
	[29]	Inspect
10	(H)	To oil
	(30)	Oil
126	(K)	To elevator
45	(E)	Up 3 floors
120	(K)	To part stores
	▽	Part stores
240	(H)	To bench
	(31)	Assemble

PROCESS FLOW CHART
MODEL 33 RECEIVER
NEW LAYOUT

TRAVEL: (Feet)	OPERATION:	DESCRIPTION:
	▽	Raw stores
150	○ Crane	To press
	(1)	Blank and pierce
10	(M)	To press
	(2)	Pierce 2 locating holes
10	(M)	To press
	(3)	First form
10	(M)	To press
	(4)	Second form
10	(M)	To press
	(5)	Finish form
323	(K)	To drill
	(6)	Drill and assemble rivets
18	(M)	To riveter
	(7)	Rivet inserts
2	(M)	To bench
	(8)	Burr rivets and rear end
14	(M)	To handscrew machine
	(9)	C-bore and face front end
30	(M)	To wash tank
	(10)	Wash
24	(M)	To drill
	(11)	Drill 3 holes
14	(M)	To lathe
	(12)	Line ream 3 holes
16	(M)	To powermill
	(13)	Powermill loading opening
18	(M)	To handmill
	(14)	Handmill recoil slot
4	(M)	To press
	(15)	Shave bolt lug slot
6	(M)	To profile
	(16)	Profile bolt slot
10	(M)	To wash
	(17)	Wash
8	(M)	To bench
	(18)	Finish file
16	(M)	To tapping machine
	(19)	Tap front end
8	(M)	To wash
	(20)	Wash
4	(M)	To bench
	[21]	Inspect
8	(M)	To jack
	(22)	Polish
3	(M)	To press
	(23)	Stamp number
18	(M)	To bench
	(24)	Finish corner and inspect
208	(K)	To brown
	(25)	Brown
20	(M)	To bench
	[26]	Inspect
80	(C)	To assembly
	▽	Before assembly
	(27)	Assemble

SUMMARY

	Old		New		Dif.	
Total oper.	31		27		4	
Total trav.(Ft.)	7547		1058		6489	
Total moves:	No.	Dist.	No.	Dist.	No.	Dist.
By elec. truck (K)	9	4035'	2	531'	7	3504'
By hand truck (H)	22	3250'	-	-	22	3250'
By man (M)	6	157'	23	427'	17	270'
By conveyor (C)	-	-	1	100'	1	100'
By elevator (E)	5	105'	-	-	5	105'

○ Denotes an operation
○ Denotes a transportation
▽ Denotes a temporary storage
▽ Denotes a permanent storage
□ Denotes an inspection

FIGURES 6 AND 7. Typical process flow charts of old and new methods with summary of savings made, and below the summary the symbols used in making the charts

marized at the bottom of the chart. A typical chart is shown in Figure 6.

On first looking at this chart it may seem that such detail is entirely unnecessary. The route sheet or operation listing gives only a few items for such a chart. However, when a plant layout is made that is based only on this route sheet, it is likely to be an approximation rather than a complete layout designed to consider all phases of the operation.

MAKE A CHART OF YOUR OWN

Before passing judgment on the value of such a flow process chart, make one on one of the simplest parts produced in your own plant and summarize it as shown in Figure 7. Too much detail cannot be shown in a flow process chart. Every single step in the movement of the work *must* be shown if the chart is to be of any value. Unnecessary steps cannot be eliminated unless they are first brought to light. You cannot draw a flow process chart sitting at a desk. The part must actually be followed throughout the operation.

To aid in visualizing the flow of work, flow diagrams (Figure 8) are drawn approximately to scale. These diagrams emphasize the existence of backtracking or bottlenecks. While these phenomena do appear in the summary of the flow process chart as excessive distance traveled, the existence of many parallel lines on the flow diagram bring them to light and may offer suggestions for improvement.

If working on a plant located in a multi-story building, an isometric diagram instead of a single floor plan may be necessary. Such a flow diagram is illustrated in Figure 10.

A CHART FOR EVERY PART?

What of the plants where there are many parts? Naturally, all operations are not as simple as would be indicated in the chart shown here. In the first place, most manufacturing plants bring together several parts or sub-assemblies and finally carry them through to finished assembly. A simple illustration is indicated in Figure 11, which shows the operations performed in inspecting and packing a pair of tennis shoes.

Another problem is that presented by a product that may be made up in many varieties, styles, or models. Here it is not necessary to make a complete flow process chart for each one of these separate sizes or models—much of this work can be simplified. A page from the flow process chart made in making the electric motor layout previously mentioned, is illustrated in Figure 12. Here the various types of coils are classified from A to F, and the chart is drawn as shown.

Naturally, in a plant making 50,000 different parts, one cannot expect to draw 50,000 flow process charts. Here one starts with the major components,

charts them in full detail from start to finish. Perhaps one or two models may account for the greatest volume of production. If so, they can be charted in detail, and then any variations noted for the remaining items making up the balance of the work. Many different parts will fall into certain groups or classifications. One chart made on a certain part will be typical of many others, and this need be the only one drawn for that class of work. For example, two or three charts on screw machine parts will usually suffice to cover all the work going to that department, though there may be several thousand parts all told.

FOLLOW THE OPERATOR

Process charts can also be made by following the operator rather than the part or product, and such charts may of course be common for a great many different items. In fact, before going too far with any layout, operator charts should be made to check machine grouping.

After the chart is made, it should be summarized. In many cases, it is a good plan not only to add the distance traveled to the items on the chart, but to show time as well. This figure is usually shown only for operations and inspections, as the transportations and storages will often vary a great deal. However, it is sometimes worth while to check at least one part by putting down an actually observed time for each one of the symbols as checked in following the parts through from start to finish, or securing some of this information from the standards, if they are available. Then check over the records and find out on the average how long it takes for the part to go from the beginning of the operation to the end. It is not at all uncommon to find that total time, exclusive of storages, may be a matter of hours, whereas average actual elapsed time may be days, or even weeks. This will again emphasize the opportunity in control by product for improvement in speeding the work through the plant.

Another way of getting a check on this is to send one lot or part through "extra special rush." Time this lot and then check with the time usually taken under normal conditions. In almost every plant one will hear of records that have been attained under unusual circumstances—which ought to raise the question, "Why can't it be done all the time?"

SIX ETERNAL QUESTIONS

After the flow chart covering the main items has been completed, the present method is studied for possible improvement. Kipling once said:

"I keep six honest serving men,
They taught me all I knew;
Their names are WHAT and WHY
and WHEN,
And HOW and WHERE and WHO."

These questions are ones that may well be asked of every step on the flow process chart. It is essential that one go at this job with an open mind, without any preconceived notion that the present method is as good as can be attained. It might also be well to stress right at the beginning that it is difficult for any one person to sit down and accomplish much in questioning a process chart on an operation with

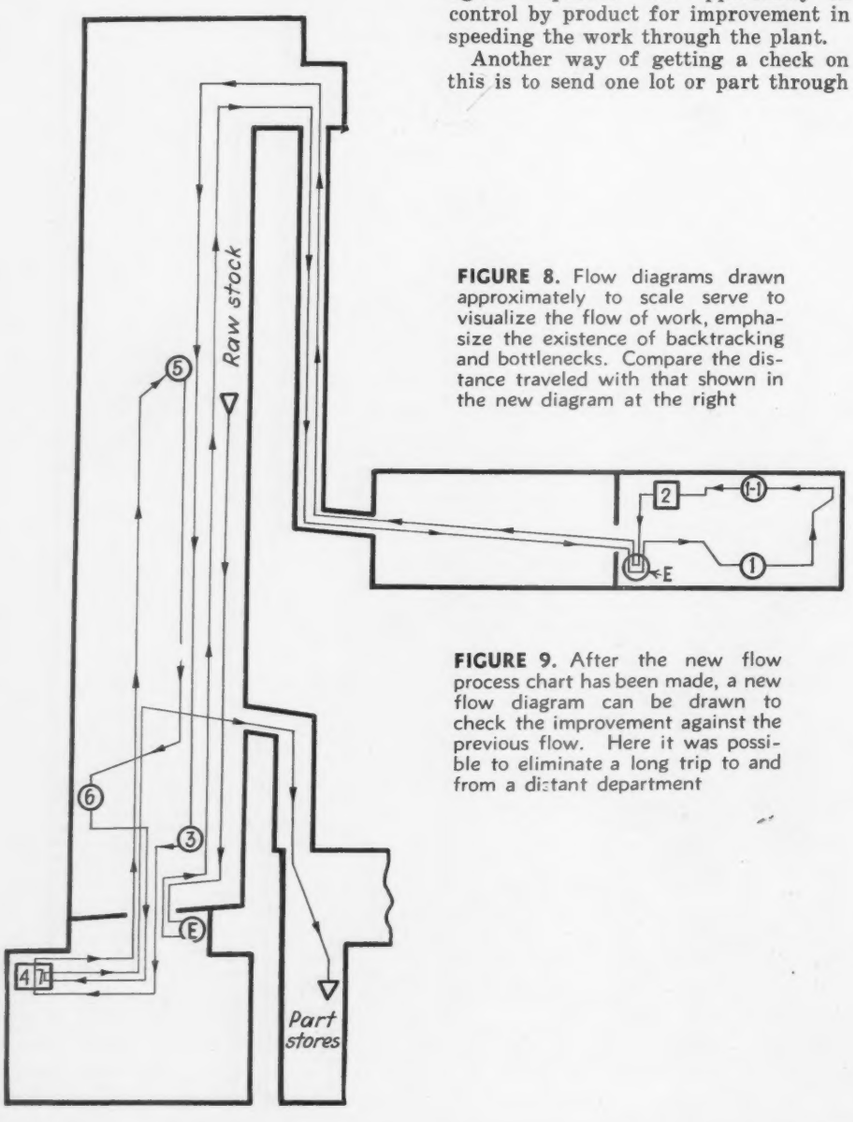
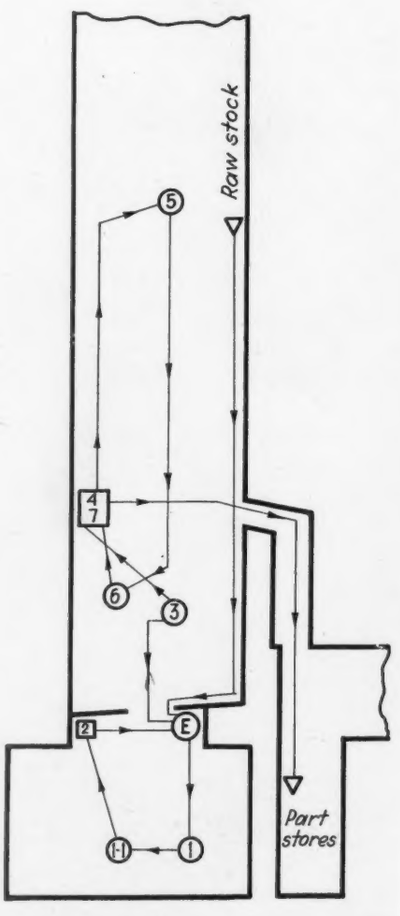


FIGURE 8. Flow diagrams drawn approximately to scale serve to visualize the flow of work, emphasize the existence of backtracking and bottlenecks. Compare the distance traveled with that shown in the new diagram at the right

FIGURE 9. After the new flow process chart has been made, a new flow diagram can be drawn to check the improvement against the previous flow. Here it was possible to eliminate a long trip to and from a distant department



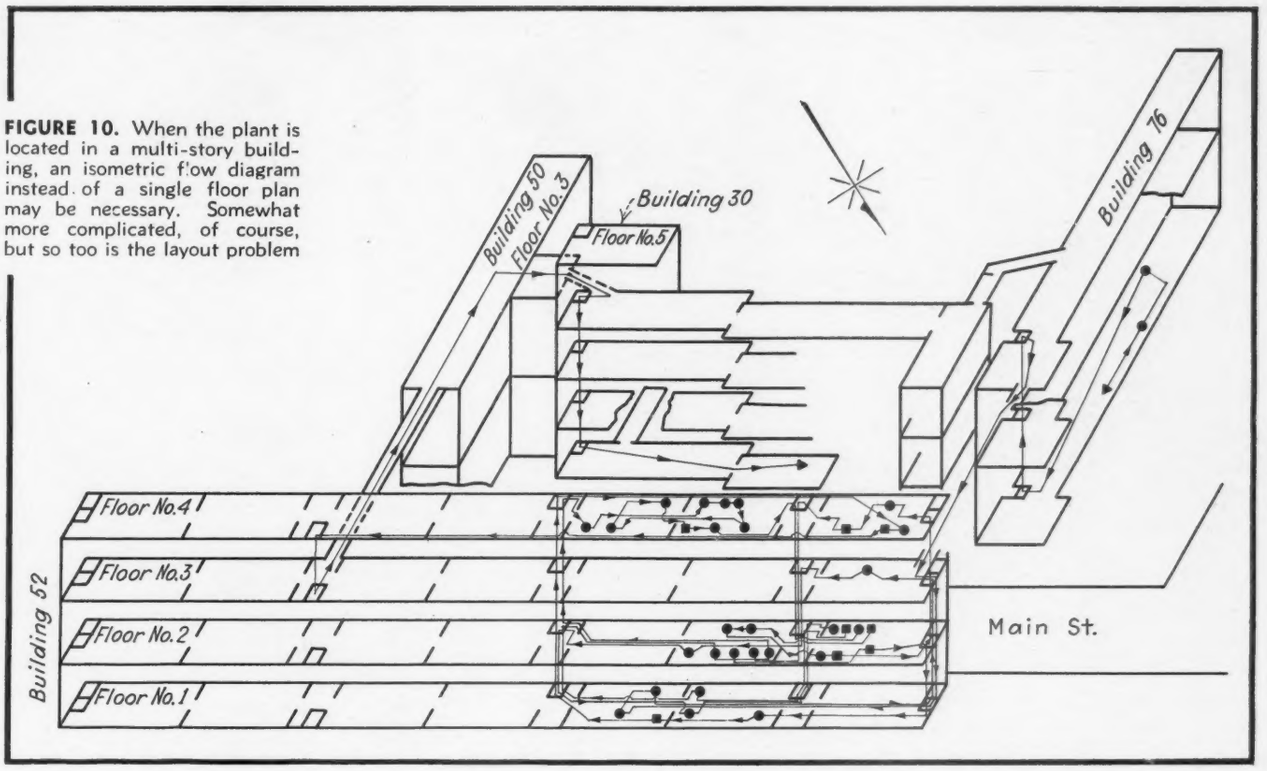


FIGURE 10. When the plant is located in a multi-story building, an isometric flow diagram instead of a single floor plan may be necessary. Somewhat more complicated, of course, but so too is the layout problem

which he is thoroughly familiar. By getting several people in on the discussion, and having the benefit of their various points of view, considerably more can be accomplished than by one man sitting down and trying to do the job all by himself.

Every single symbol on the chart should be subjected to the following four questions:

1. Can operation be eliminated?
2. Can it be combined with some other operation?
3. Can we change the sequence of operation?
4. Can operation be simplified?

1. CAN WE ELIMINATE?

In far too many instances we devote a good deal of time to studying the major operations for possibilities of improvement without asking the question, "Why do we perform this operation?" In front of me is a report from an executive who was recently introduced to a department which had been steadily increasing in size, but which continued to be the "bottleneck" for an important part of the routine. He says:

"A cursory survey indicated that some very intelligent and effective work had been done in cleaning up clerical production, routing, personnel selection; and the supervision was above the average, for all of which the management was quite proud.

"But their enthusiasm for the orthodox procedure of so-called scientific office management obscured the more fundamental factors in their problem. No one had taken the objective view to inquire why the work was being performed in this unit rather than elsewhere. Were the data assembled needed in the form prepared? Could certain forms be duplicated rather than individually typed? Answers to these and other questions indicated that this highly efficient department could be and was eliminated in its entirety, and one-half time of a single Ditto operator produced in a more satisfactory manner the work of the unit consisting of sixteen clerks and a supervisor."

Dr. Lillian Gilbreth once said: "Entirely too many operations are studied that should never be done at all." Therefore, the first question should not be abandoned until every possible effort has been made to eliminate the operation. This is not an easy task, especially if the person or persons who are attempting to answer it are intimately familiar with the operation or have been doing it for some time. It is precisely for this reason that the viewpoint of the outsider is so valuable when new layouts are being considered and the work of making them is getting under way.

The ability to ask WHY is often responsible for unusual success on the part of the outside man. One often hears it said that the only man to do a plant layout job is an outside consultant. Coming into the plant for the first time, he naturally asks WHY at every step, and in all too many instances finds that the answer is, "Well, we have always done it this way." If that is the only reason that can be given, it certainly should be questioned. One chief manufacturing executive recently said: "If I find that an operation has been done in my plant the same way for six months, I feel that it should be questioned. If I find that it has been done the same way for a year, I know damn well it is wrong."

The flow process chart enables you to take the outside viewpoint. It gives you an opportunity to get off a bit from the operation, to take a bird's-eye view of the whole situation. There is no way to picture the whole integrated operation of a plant as effectively as having complete flow process charts in front of you.

First and easiest of all the symbols to challenge are the transportations and the storages. Whenever you see a part carried an appreciable distance the question WHY should immediately suggest possible grouping of equipment to eliminate this travel.

Question every single handling. Then, if handling is absolutely necessary, look for (1) Backtracking of work; (2) heavy lifting or carrying; (3) trucking; (4) bottlenecks; (5) skilled operators doing handling work. Then try to use all mechanical means possible, keep material moving in one

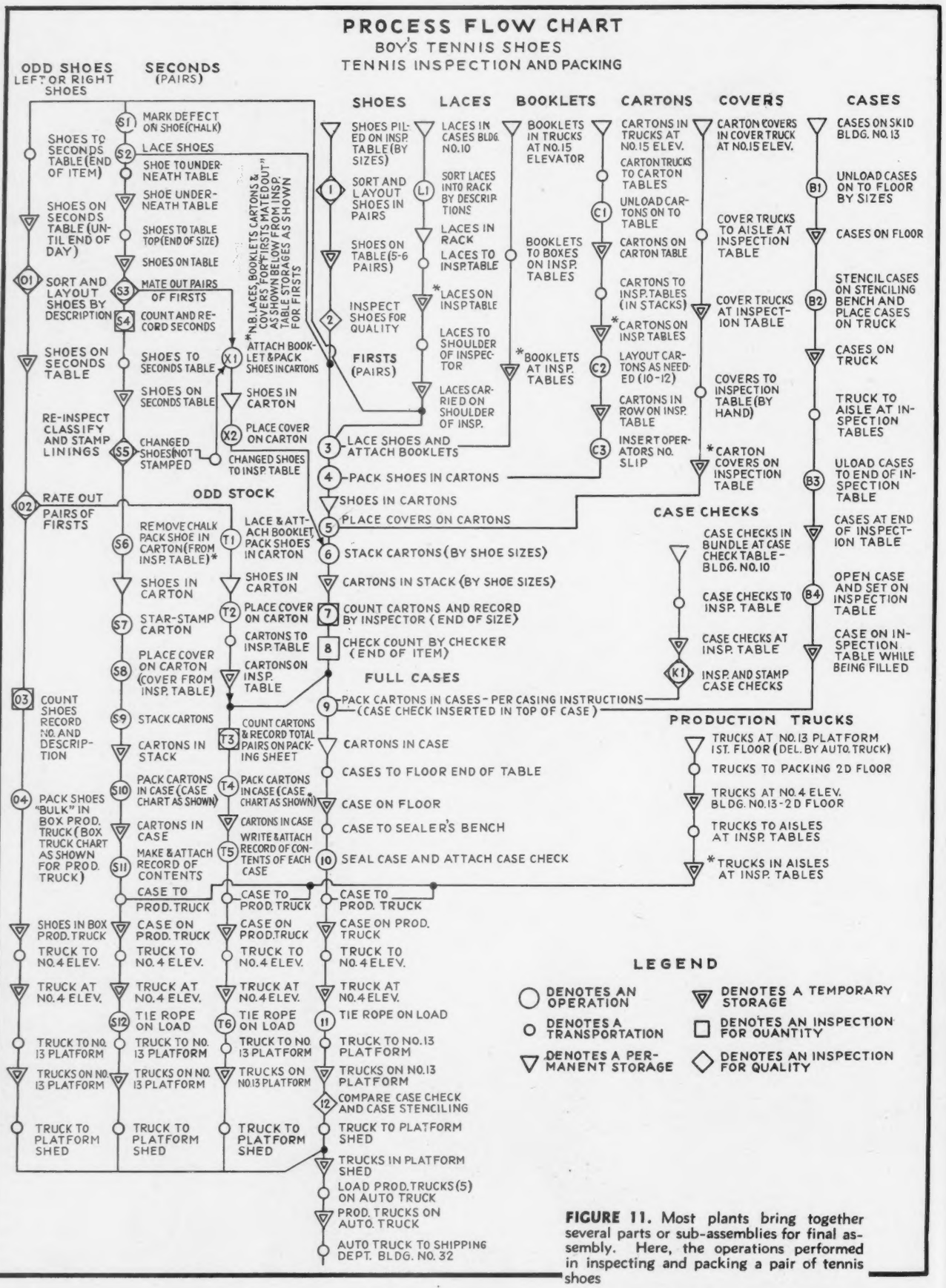

PROCESS FLOW CHART
BOY'S TENNIS SHOES
TENNIS INSPECTION AND PACKING
ODD SHOES LEFT OR RIGHT SHOES
SECONDS (PAIRS)
SHOES
LACES
BOOKLETS
CARTONS
COVERS
CASES
MARK DEFECT ON SHOE (CHALK)
LACE SHOES
SHOES TO SECONDS TABLE (END OF ITEM)
SHOE TO UNDERNEATH TABLE
SHOE UNDERNEATH TABLE
SHOES ON SECONDS TABLE (UNTIL END OF DAY)
SHOES TO TABLE TOP (END OF SIZE)
SHOES ON TABLE
SORT AND LAYOUT SHOES BY DESCRIPTION
MATE OUT PAIRS OF FIRSTS
COUNT AND RECORD SECONDS
*N.B. LACES, BOOKLETS CARTONS & COVERS FOR FIRSTS MATED OUT AS SHOWN BELOW FROM INSP. TABLE STORAGES AS SHOWN FOR FIRSTS
SHOES ON SECONDS TABLE
SHOES TO SECONDS TABLE
ATTACH BOOKLET & PACK SHOES IN CARTONS
SHOES ON SECONDS TABLE
SHOES IN CARTON
RE-INSPECT CLASSIFY AND STAMP LININGS
CHANGED SHOES (NOT STAMPED
PLACE COVER ON CARTON
CHANGED SHOES TO INSP. TABLE
RATE OUT PAIRS OF FIRSTS
ODD STOCK
REMOVE CHALK PACK SHOE IN CARTON (FROM INSP. TABLE)*
LACE & ATTACH BOOKLET, PACK SHOES IN CARTON
SHOES IN CARTON
SHOES IN CARTON
STAR-STAMP CARTON
PLACE COVER ON CARTON
CARTONS TO INSP. TABLE
PLACE COVER ON CARTON (COVER FROM INSP. TABLE)
CARTONS ON INSP. TABLE
COUNT SHOES RECORD NO. AND DESCRIPTION
STACK CARTONS
CARTONS IN STACK
COUNT CARTONS & RECORD TOTAL PAIRS ON PACKING SHEET
PACK SHOES "BULK" IN BOX PROD. TRUCK (BOX TRUCK CHART AS SHOWN FOR PROD. TRUCK)
PACK CARTONS IN CASE (CASE CHART AS SHOWN)
PACK CARTONS IN CASE (CASE CHART AS SHOWN)
CARTONS IN CASE
CARTONS IN CASE
MAKE & ATTACH RECORD OF CONTENTS
WRITE & ATTACH RECORD OF CONTENTS OF EACH CASE
CASE TO PROD. TRUCK
CASE TO PROD. TRUCK
CASE TO PROD. TRUCK
SHOES IN BOX PROD. TRUCK
CASE ON PROD. TRUCK
CASE ON PROD. TRUCK
CASE ON PROD. TRUCK
TRUCK TO NO. 4 ELEV.
TRUCK TO NO. 4 ELEV.
TRUCK TO NO. 4 ELEV.
TRUCK TO NO. 4 ELEV.
TRUCK AT NO. 4 ELEV.
TRUCK AT NO. 4 ELEV.
TRUCK AT NO. 4 ELEV.
TRUCK AT NO. 4 ELEV.
TIE ROPE ON LOAD
TIE ROPE ON LOAD
TIE ROPE ON LOAD
TRUCK TO NO. 13 PLATFORM
TRUCK TO NO. 13 PLATFORM
TRUCK TO NO. 13 PLATFORM
TRUCK TO NO. 13 PLATFORM
TRUCKS ON NO. 13 PLATFORM
TRUCKS ON NO. 13 PLATFORM
TRUCKS ON NO. 13 PLATFORM
TRUCKS ON NO. 13 PLATFORM
COMPARE CASE CHECK AND CASE STENCILING
TRUCK TO PLATFORM SHED
TRUCK TO PLATFORM SHED
TRUCK TO PLATFORM SHED
TRUCK TO PLATFORM SHED
TRUCKS IN PLATFORM SHED
LOAD PROD. TRUCKS (5) ON AUTO TRUCK
PROD. TRUCKS ON AUTO. TRUCK
AUTO TRUCK TO SHIPPING DEPT. BLDG. NO. 32
SHOES PILED ON INSP. TABLE (BY SIZES)
SORT AND LAYOUT SHOES IN PAIRS
SHOES ON TABLE (5-6 PAIRS)
INSPECT SHOES FOR QUALITY
FIRSTS (PAIRS)
LACES IN CASES BLDG. NO. 10
SORT LACES INTO RACK BY DESCRIPTIONS
LACES IN RACK
LACES TO INSP. TABLE
*LACES ON INSP. TABLE
LACES TO SHOULDER OF INSPECTOR
LACES CARRIED ON SHOULDER OF INSP.
BOOKLETS IN TRUCKS AT NO. 15 ELEVATOR
BOOKLETS TO BOXES ON INSP. TABLES
*BOOKLETS AT INSP. TABLES
CARTONS IN TRUCKS AT NO. 15 ELEV.
CARTON TRUCKS TO CARTON TABLES
UNLOAD CARTONS ON TO TABLE
CARTONS ON CARTON TABLE
CARTONS TO INSP. TABLES (IN STACKS)
*CARTONS ON INSP. TABLES
LAYOUT CARTONS AS NEEDED (10-12)
CARTONS IN ROW ON INSP. TABLE
INSERT OPERATORS NO. SLIP
CARTON COVERS IN COVER TRUCK AT NO. 15 ELEV.
COVER TRUCKS TO AISLE AT INSPECTION TABLE
COVER TRUCKS AT INSPECTION TABLE
COVERS TO INSPECTION TABLE (BY HAND)
*CARTON COVERS ON INSPECTION TABLE
CASES ON SKID BLDG. NO. 13
UNLOAD CASES ON TO FLOOR BY SIZES
CASES ON FLOOR
STENCIL CASES ON STENCILING BENCH AND PLACE CASES ON TRUCK
CASES ON TRUCK
TRUCK TO AISLE AT INSPECTION TABLES
ULOAD CASES TO END OF INSPECTION TABLE
CASES AT END OF INSPECTION TABLE
OPEN CASE AND SET ON INSPECTION TABLE
CASE ON INSPECTION TABLE WHILE BEING FILLED
LACE SHOES AND ATTACH BOOKLETS
PACK SHOES IN CARTONS
SHOES IN CARTONS
PLACE COVERS ON CARTONS
STACK CARTONS (BY SHOE SIZES)
CARTONS IN STACK (BY SHOE SIZES)
COUNT CARTONS AND RECORD BY INSPECTOR (END OF SIZE)
CHECK COUNT BY CHECKER (END OF ITEM)
FULL CASES
PACK CARTONS IN CASES - PER CASING INSTRUCTIONS (CASE CHECK INSERTED IN TOP OF CASE)
CARTONS IN CASE
CASES TO FLOOR END OF TABLE
CASE ON FLOOR
CASE TO SEALER'S BENCH
SEAL CASE AND ATTACH CASE CHECK
CASE CHECKS
CASE CHECKS IN BUNDLE AT CASE CHECK TABLE - BLDG. NO. 10
CASE CHECKS TO INSP. TABLE
CASE CHECKS AT INSP. TABLE
INSP. AND STAMP CASE CHECKS
PRODUCTION TRUCKS
TRUCKS AT NO. 13 PLATFORM 1ST. FLOOR (DEL. BY AUTO. TRUCK)
TRUCKS TO PACKING 2D FLOOR
TRUCKS AT NO. 4 ELEV. BLDG. NO. 13 - 2D FLOOR
TRUCKS TO AISLES AT INSP. TABLES
*TRUCKS IN AISLES AT INSP. TABLES
LEGEND
DENOTES AN OPERATION
DENOTES A TRANSPORTATION
DENOTES A PERMANENT STORAGE
DENOTES A TEMPORARY STORAGE
DENOTES AN INSPECTION FOR QUANTITY
DENOTES AN INSPECTION FOR QUALITY

FIGURE 11. Most plants bring together several parts or sub-assemblies for final assembly. Here, the operations performed in inspecting and packing a pair of tennis shoes

direction, use proper loading, unloading and stacking.

If it is found impossible to eliminate an item, then the next question is asked:

2. CAN WE COMBINE?

This opportunity for improvement is one that should not be overlooked. Wherever two operations can be combined, they are often performed for the labor cost involved in only one of them, or for less. Likewise all transportations and storages between the two operations are eliminated. Combining operations results many times in improved quality. It may eliminate useless inspections between operations. If operations cannot be combined, ask if it is possible to combine a transportation and operation. Many of the automobile companies have concentrated on this lately. Until recently it was thought that, if an object was being moved, say, from one conveyor line to another, and a mechanical handling means was provided, that was as far as they could go. However, even this practice has been questioned, and in many instances a touch-up or a finishing operation can be performed in the 10 ft. or so involved in moving from one location to another.

Many inspections can be combined with an operation. When we inspect, it is usually necessary to take the piece out of the box or container and then return it to another container. This usually either follows or precedes an operation. By combining this inspection with one of the operations, all this handling is eliminated.

If it is not possible to combine any of the symbols on the chart, we then go to the third question:

3. CAN WE CHANGE THE SEQUENCE?

Here is where the flow diagram often offers suggestions. By changing the sequence of an operation one may be able to eliminate backtracking of work. Much of the order in which the operations are performed is naturally necessary as a part of the process. However, there are many instances where a change in sequence can be made with consequent saving. In some cases the sequences that have been set up are entirely due to the fact that we are operating on a process control basis, and it is necessary for work to follow around in that order so that the proper supervision can be given. By going to product control, however, much of this procedure can be revised.

Then, finally, if no further changes in sequence can be made, and only then, do we ask the last question:

4. CAN WE SIMPLIFY?

Unfortunately this is where a great deal of our layout work in the past has started. Many layouts are made on the principle that by taking a few of the key operations and replacing them with operations performed on more modern equipment, and then perhaps rearranging the equipment somewhat, a new layout can be secured. All this is, really, is a shifting over of all the bad methods that were in use before into a new location, with some slight savings secured, whereas if the job were done thoroughly, the returns on the investment would perhaps be many times those secured through the rearrangement alone. No plant changes should be made until every single phase of the operation as it is now being performed has been questioned, as indicated above, and then studied for further simplification.

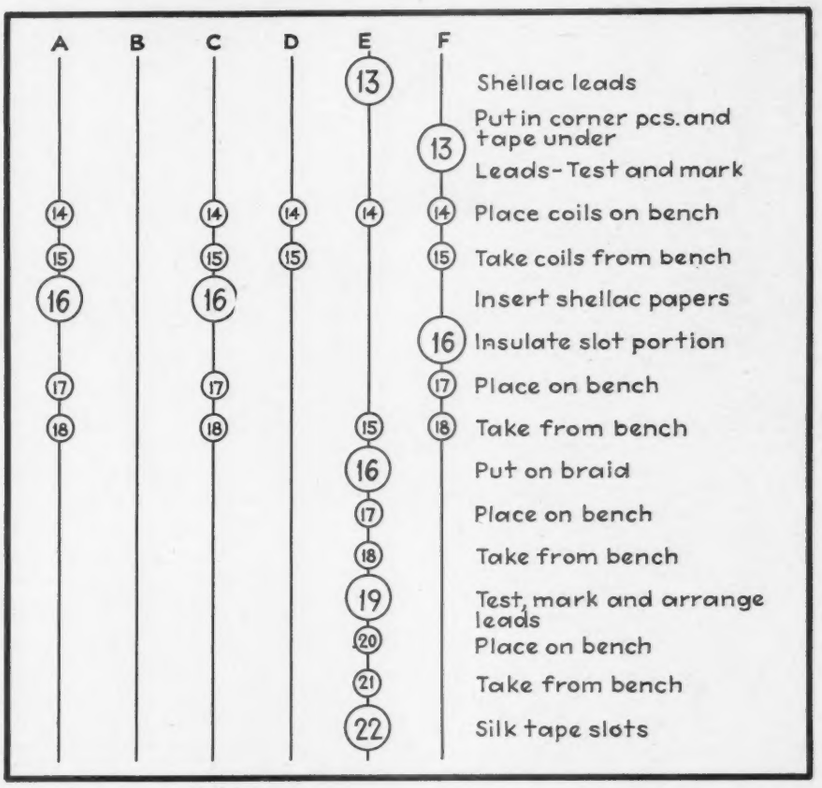


FIGURE 12. A page from the flow process chart made in making the electric motor layout described in the text. The various types of coils are classified from A to F, thus simplifying the task

OUT OF BALANCE

One of the faults of much of the original motion-study work done lay right at this point. Various operations were selected, sometimes on a basis of their ease of study, or perhaps the high cost of that particular operation, and then this operation was subjected to a thorough motion analysis. In some cases unusual savings were secured on the operations studied, but the picture as a whole was only slightly improved. Sometimes all it did was throw the whole line out of balance, because if you have a set-up made for a smooth flow of work through that line and increase production 300 or 400 per cent at one point, it may not do much good.

USUAL PROCEDURE REVERSED

The use of a flow process chart reverses the usual procedure in making a layout study. Instead of making a change in any subdivision of a process merely because that subdivision may be the easiest to change, or may appear to be the one offering the greatest opportunity for improvement, it permits consideration of all those subdivisions preceding and following the subdivision. Unless they are all considered, the change may be found entirely unsuited to the ultimate plan of operation.

In making a flow process chart of present methods, do not neglect the opportunity to solicit suggestions from those working directly on the operation. It is often assumed that workmen and foremen are not capable of making such suggestions, whereas some of the most valuable have come from this source. Several plant rearrangements have been made recently where all the men were given an opportunity to discuss with their foreman any suggestions they might have for possible improvement. Various foremen had small layout boards on their desks, and many

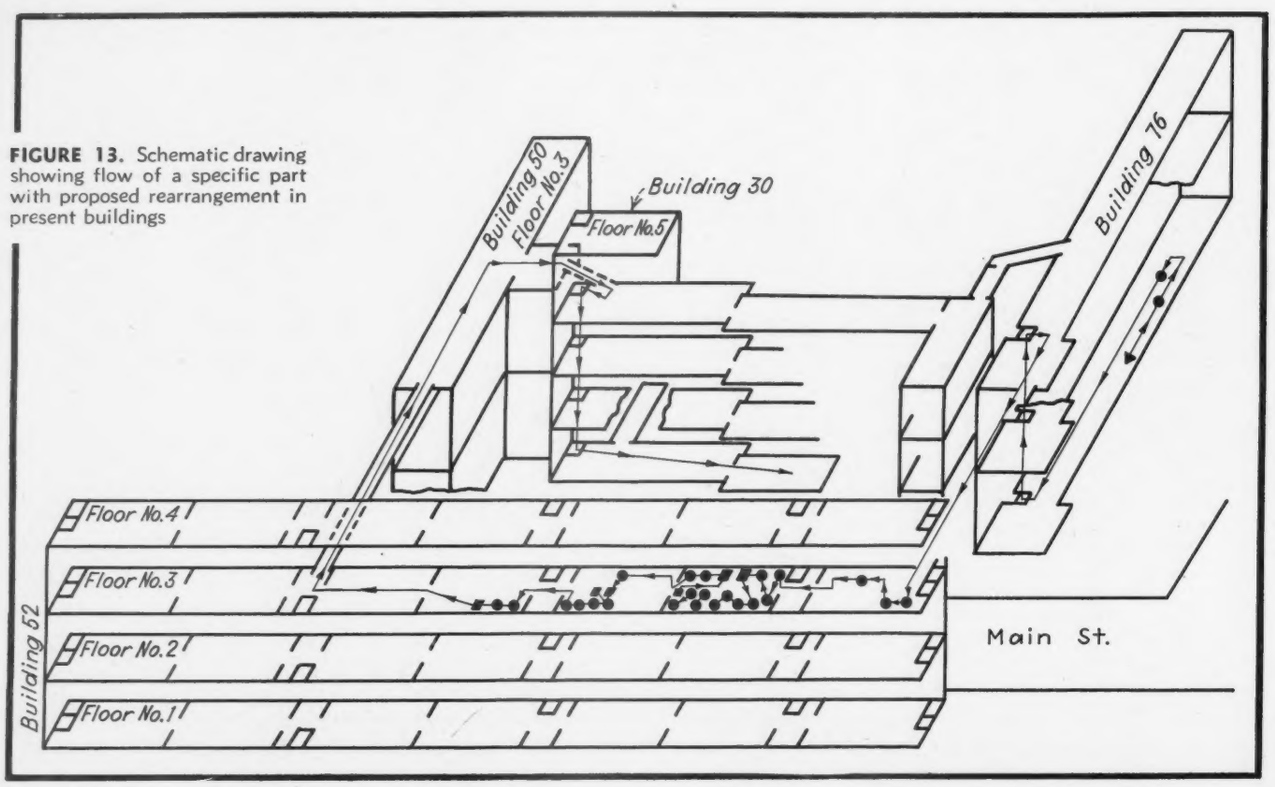


FIGURE 13. Schematic drawing showing flow of a specific part with proposed rearrangement in present buildings

of them submitted complete department layouts of their own. These were then considered in the light of the major plan, and many good ideas were incorporated.

When all possible suggestions have been obtained, the new flow process chart can be drawn up. When completed, every symbol should again be questioned to make sure that no items have been overlooked. Such a revised flow process chart is shown in Figure 7, this being the new method for the chart shown in Figure 6. Likewise, a flow diagram can be drawn to check the improvement against the previous flow. Such a new diagram is shown in Figure 9, corresponding with the one shown in Figure 8. The latter showed that this particular part was traveling to a distant department and back again. In the new diagram this unnecessary travel has been eliminated.

CONSIDER THE WHOLE

The flow diagram will naturally be drawn up with the new location in mind. If there is no other possibility but that the rearrangement must take place within the same building or area previously occupied, this is a simple matter. On the other hand, flow diagrams may be drawn for several different possibilities. Do not make departmental rearrangements without considering effect on the layout as a whole. Figures 13 and 14 were drawn to aid in the final choice of location, as in this case it meant a major move.

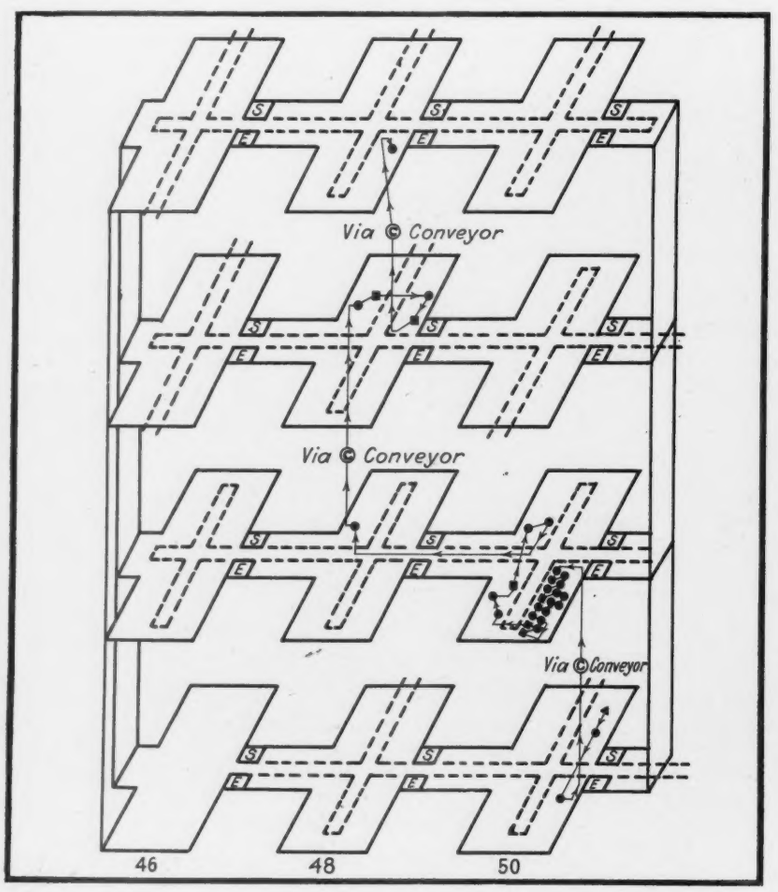


FIGURE 14. Schematic drawing showing flow of same part as in Figure 13, but with proposed rearrangement of machines in new buildings

CHAPTER THREE

Making the Templet Layout

IN THE EVENT that no change in the method of control (that is, from process to product control) is contemplated, the next step is making the templet layout. That, of course, means making a small cut-out to scale of paper or cardboard to indicate each machine to go into the layout. It is doubtful, however, that many rearrangements will be made without study showing that at least a few machines can be replaced with a different type or a newer model.

If the improvement is to be confined to only a few machines that are to be replaced, this investigation should be made at this point. Technical papers should be consulted, visits made to other plants doing somewhat similar types of work. Calling upon the manufacturers of the equipment already in use may lead them to suggest new equipment or changes in tools that will save money. If no equipment is available on the market, it may be necessary to consider design of equipment, especially for that particular operation. This equipment may either be built in the plant or perhaps be done to order outside. Relative merits of various machines and equipment can be checked as indicated later.

FROM 835 PIECES TO 1,480

Before deciding upon the number of machines to go into the new layout, a thorough study of present machine performance should be made. Performance studies may be made by an observer, or time meters or analyzers may be installed. A recent application of a time analyzer to a certain machine provided charts indicating the loss of actual production time that could be saved. Production at first averaged 835 pieces per hour. Provisions were made to overcome excess tool grinding, down time for lack of stock, and reloading time. The result was an actual increase of production to an average of 1,480 pieces per hour two weeks after the analyzer was installed, and this average has since been maintained. The theoretical maximum, or machine rate with no interruption, is 1,800 per hour. The increase in output was 77 per cent.

There are few machines that will not show idle time that can be eliminated when subjected to such an analysis. Another type of process chart known as the "man-and-machine" chart* will also give information regarding operation of equipment. Such a chart is made by analyzing the work of both operator (and helper, if any) and machine, drawing the symbols side by side, just as in the ordinary flow process chart. The summary on this chart shows specifically where time is being lost, and indicates the remedy.

If a change from process to product control is contemplated, more information on machine capacity will be necessary. If time studies on all work are available, the job is not so difficult. Accurately set time standards or even

*See Figure 4—Motion Economy Section —November, 1935.

FIGURE 15. Layouts, once made, should be at all times available for consideration of changes in process or equipment. Here is the layout used when Packard 120 production was being planned

FIGURE 16. An actual building model used in making the templet layout helps visualize flow of work through process. It corresponds to the isometric flow diagram in Figure 14, a layout in three four-story buildings

piece prices that have been in effect for some time give something with which to start. If no such information is available, one will have to rely upon the manufacturer's claims or attempt to secure some idea of performance from others who are using such equipment on similar operations.

First step in determining the amount of equipment needed is a production forecast. Some idea will have to be secured from the sales department or general management concerning the possible output of the new unit. It is usually rather difficult to pin them down to a definite figure, but unless you have something to start with the whole thing will be but a guess. The length of the working day must also be determined.

HOW MANY HOURS?

A policy must be formulated as to the number of hours that the equipment is to operate. Hand operations, assembly operations, and inexpensive machines usually operate on an eight-hour basis. Equipment that requires more investment may often operate on a two-shift basis, while equipment involving a very heavy expenditure may be run 24 hours in order to secure an adequate return.

Proper allowance must be made for set-up time. This should not be made on a general over-all allowance, but should be determined for each class of work, if possible. If accurate time standards are in effect, the set-up time will probably be available. If not, studies should be made, or estimates secured from the manufacturer. This, of course, will require a knowledge of the size of lots that are to run. This information may already be available; if not, some attempt should be made to make use of the information on economic lot sizes that is available in current literature. It can be seen that this will have a definite bearing on the problem, because if a machine is to be run only a few thousand pieces, and then torn down and set up on something else, run a few hundred and then set up again on the first one, and so on, naturally the operating efficiency will be greatly lowered and more equipment needed.

MAKE ALLOWANCES

In addition, proper allowances must be made for maintenance and repairs, and some estimate made of the efficacy of planning. Studies in the average shop will show that the percentage of performance to theoretical output will in many instances be surprisingly low. Studies made with the time meter, as mentioned before, often indicate this fact. It is usual practice to take about 80 per cent of theoretical performance and figure on that basis, but this will, of course, vary with industries, size of plant, and other conditions.

A large sheet is then made up. The various parts to be manufactured are listed down one side, together with the number of pieces going into an assembly. Across the top are listed the various machines and equipment used. Then the sheet is filled in, using the data available on set-up time and time per piece, and the hours are totaled at the bottom. This practice enables the determination of the number of machines that will be required.

This analysis may seem like a long procedure, but there is no shortcut that will still give accurate results. Naturally, the analysis need only be made on the major items in the line in such detail — approximation or groupings may take care of the minor and miscellaneous parts.

When the number of machines is finally determined and the selection of machines made, the templets should be cut out. When plants were laid out with wide aisles for trucking and machines were set along in straight lines, as illustrated in Figure 3, it was usual procedure to cut the templet to show the working area. This might include, perhaps, space for a small table, room for the trucks or boxes, and so on. However, in the light of modern practice, which indicates as close grouping of machines as possible to eliminate handling and travel, the templets should be cut only to show the actual projected area occupied by the machine itself. It must be remembered, however, that such things as rod stock racks for screw machines, and table travel for milling machines and shapers, should be shown as working area. Otherwise, if grouped closely, interference may occur. It is also well to check with the head of the maintenance department so that he may indicate where extra space must be allowed for replacement or repair.

Templets can be cut from various colored cards or material to indicate machine groupings, to separate old equipment from new equipment, to indicate equipment used on certain models or parts, benches, conveyors, or for many other purposes.

Next, the layout boards must be constructed. In most plants construction prints are available, which give building outlines to scale and show columns, stair wells, elevator shafts, doors, and windows. Naturally, if a new building is being considered, these prints must be drawn up for use. In general, a scale of ¼ in. to the foot is satisfactory.

These prints are then mounted on wallboard or corkboard, supported in suitable frames to give them strength. Frames should be strong enough to bear the weight of several people leaning on them, unless layout tables are available. It is often customary practice to furnish inexpensively built horses to support the layout boards during the work. They are more flexible than tables and permit of removal of the whole layout board to some other department or location, if discussion seems desirable.

ALWAYS AVAILABLE

One thing should be emphasized. These layout boards should not be regarded as having a useful life only during the actual layout. Once made up, they should be kept for future revisions. The layout of the Plymouth plant, shown in Figure 2, is mounted on a wall in the production offices, and is at all times available for consideration of change in process or equipment. It may be desirable to make up various

small layouts for work purposes and then transfer these to a master layout as finally approved. Figure 15 shows the master layout developed by the Packard planning department in laying out the plant for the Packard 120.

If a layout is being made for a multi-story plant, the various boards may be fitted into a model built to represent the completed arrangement. Just as the schematic flow diagrams, shown in Figures 10, 13, and 14, were of assistance in the early blocking out, so the actual building model used in making the templet layout was of great assistance in visualizing the flow of work throughout the process.

BUILDING MODEL

The model is illustrated in Figure 16. It corresponds to the isometric flow diagram in Figure 14, a layout in three four-story buildings, with several additional service buildings. Constructed of light lumber, it acted as a rack for each floor plan, and gave an instant picture of each department in its proper relation to the others. It also helped to visualize the possibilities for materials-handling equipment, chutes for chips, piping, etc. Elevators were indicated by painting the adjacent vertical strip. Such a rack may well serve as a permanent file for the layout boards after the job is completed.

During the actual layout work, it is good practice to cover each layout board with heavy paper or Fabrikoid, cut to size and attached to a light wooden rod to facilitate rolling, because working on a dusty board soon gives it a messy appearance.

So far we have discussed layouts in only one plane, inasmuch as each floor is concerned. Overhead equipment, such as conveyors and drying ovens, may be indicated on the floor plan by using transparent vellum or tracing cloth tacked on top of the templet representing equipment located on the floor. Colored Cellophane has also been used to good advantage. However, in some instances, layouts have actually been made to scale in three dimensions. Close examination of Figure 2 will indicate several points where conveyors are shown leaving the floor level and going overhead, and one or two overhead structures representing actual conditions.

In other instances, layout engineers have felt justified in going to three dimensional representation. Such models were illustrated in February, 1935, and March, 1935, issues, as used by the Ingersoll Milling Machine Company to assist Packard executives in visualizing the proposed new line. Such elaborate layouts, however, are not usually justified.

To fasten templets to the layout board, thumb tacks, regular tacks, map pins, or wire staples may be used. Templets may be attached with Scotch drafting tape on the back. Another method that has been used successfully is to apply white rubber paper cement to the back of the templet. This can then be spotted in position and sets quickly, keeping the templet from moving, but allowing its removal and immediate relocation at any subsequent date. Map pins are good because they may be obtained with heads of various colors, indicating certain differences in machines or products, and because they permit easy stringing up in following the flow of work. Wire staples are the easiest to attach; many office staplers have a removable base and fasten the templet securely to the board with a light blow. They can then be removed with the blade of a pen knife, but must be replaced each time, whereas the map pin can be used over and over again.

As stated before, good time studies and standards are essential for actual grouping of machines. These studies should not be made merely in the conventional fashion, but wherever possible should show all details of actual idle machine time. If such time has already been utilized by having the operator turn to operate another machine located immediately adjacent, it may still offer an opportunity for further machine grouping. Naturally, in a strictly jobbing plant, where a continually varying amount of work is coming through, one cannot expect to go as far in grouping machines for greatest effectiveness as in a line-up made for only one part or product.

There are many possibilities in this machine grouping, and every effort should be made to analyze all operations with this thought in mind before proceeding too far with the layout. It is one of the big opportunities to secure much lower labor cost, and yet at the same time make the work easier

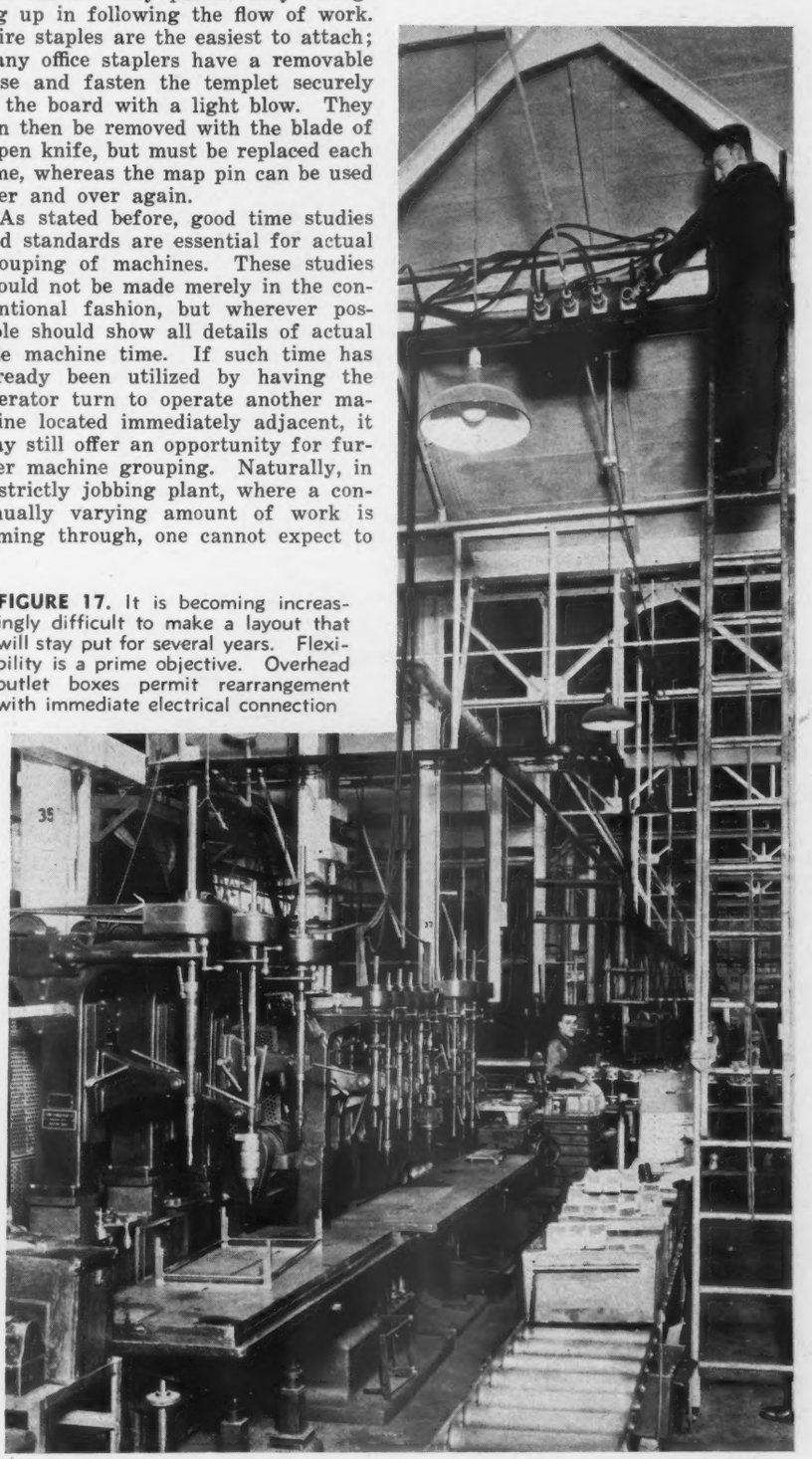


FIGURE 17. It is becoming increasingly difficult to make a layout that will stay put for several years. Flexibility is a prime objective. Overhead outlet boxes permit rearrangement with immediate electrical connection

for the operator. Much has already been said about real motion study not being a speeding-up process. Such a study does not result in "stretch-out" or "speed-up." Motion study merely seeks to find the one best way, which is usually the easiest way.

If new equipment is to be secured with a view to including it in such groups, every effort should be made to secure actual time-study information from the manufacturer of the equipment. If it cannot be secured, an effort should be made to bring the machine into the plant and set it up for a test run, during which time studies can be made, if the equipment is important enough to warrant such preliminary investigation. This is necessary because in regrouping machines we must separate "load and unload time" from "cutting time" in the cycle, in order to have an operator correctly run more than one machine.

When the preliminary arrangements have been completed, the templets may be fastened to the board and the layout strung up. This is done to indicate the flow of work for the major items to be processed, and consists of running colored strings to each piece of equipment used. Such stringing is indicated in Figure 16, and on close examination in Figure 2.

BACKTRACKING APPARENT

Naturally, it is not always necessary to follow this step, but in most instances the time so spent is well worth while. Backtracking is immediately apparent, and attention is directed to lack of handling or storage space. Total distance traveled is readily determined. There is no better time to save a few feet of travel than right here and now.

Consequently, in some of the plants where good layout work is being done, it has become somewhat of a game to see how many pieces of string could be cut out of the layout as discussions and refinements progressed. Bunching of the string through one aisle or passage naturally gives warning that there may be congestion at this point. These bottlenecks cost much money in delays and spoilage.

One more point concerning the templets. It may take longer to make templets showing complete information on each machine, rather than merely indicating the machine number, but the effort will pay for itself later on. Individually driven machines should have motors and starting controls indicated. Belt-driven equipment should have the pulley location and direction clearly marked on the templet.

There is no space here to go into a discussion of individual and group drive. Each case must be decided only upon its economic merits. If individually driven equipment is to be used, there are two possibilities. One is to mount all control apparatus directly on the machine so that to move the equipment requires breaking only one connection. The other, and a more recent adaptation, is to have receptacles located throughout the plant, or use a method of distribution that makes plugging in at any point a simple matter. Such an installation is shown in Figure 17. Thus a machine may be moved into place and very quickly set in operation.

This point is mentioned because the layout of the future should have flexibility as one of its prime objectives. It is becoming increasingly more difficult to make a layout that will stay put for several years. Changes in product, in methods of manufacture, in materials, and so on, all mean that for effective operation the layout should continually be brought up to date by moving equipment for greatest efficiency.

Naturally, more than one layout will be made for each department or building. Either several separate boards should be made, or at least a record kept, to save much going over of work already done. One way is to photostat each layout before tearing it up to make changes. Take plenty of time on this phase of the work, as it is much cheaper to make the mistakes and consequent corrections on paper than physically moving equipment later on.

CHAPTER FOUR

Installing the Layout

WITH THE templet layout finally completed and approved, the next step is to install it. Any new layout, to be successful, must be sold not only to the management, who must decide whether the return will justify the expenditures, but also to the men who will have to operate it.

It is here that the process-chart method has distinct advantages over any other approach. In the first place, many of these flow process charts will be made by the men themselves. A foreman or supervisor who has taken an active part in working out flow process charts and seeing how they develop into new layouts cannot help feeling that it is partly his layout. He is therefore going to work to see that it operates successfully.

Likewise, flow process charts showing both old and new methods cannot help stressing the advantages of the new method over the old. Display of old and new methods demands attention. This visual comparison is, of course, not enough. Actual savings must be translated into dollars and cents.

LESS WORKING CAPITAL

All items here must be considered. Reduced manufacturing interval can be expressed in terms of reduction of working capital required. Although industry has in recent years made considerable progress in increased turnover, comparison with that obtained in automotive, radio, and refrigerator plants may convince one that there is still much to be done. When you have in one industry a concern making heavy equipment for huge generating plants, and securing a turnover of seven times per year, and in an adjacent building turning over refrigerators 45 times per year, and then find another concern making industrial equipment but actually securing a turnover of but one in four years, it is evident that within these ranges lie many opportunities for improvement.

WHEN TO BUY

Four important situations may occur in the consideration of equipment:*

1. Substitution of a machine for a manual operation.

This computation requires the use of direct labor only. The decision as to whether 30 calculating machines should be purchased.

PRESENT METHOD (Calculating done manually)

Requires 70 clerks at an average salary of $20 per week.

PROPOSED METHOD (Using 30 calculating machines)

Cost of machines installed, $10,500.

Will require only 60 clerks at the same pay.

Expense of new equipment would be at the following rates:**

Interest on investment	6%
Depreciation	20
Insurance	4
Upkeep	3
Power and supplies	2

COMPARATIVE COSTS

	Present	*Proposed*
Operating Costs		
Clerical Salaries	$72,800	$62,400
Power and Supplies		210
Fixed Expense		
Interest on Investment		630
Depreciation		2,100
Insurance		420
Upkeep		315
Total	**$72,800**	**$66,075**
Net Saving per year		**6,725**

*Examples from "Management of an Enterprise," by Balderston, Karabasz & Brecht (Prentice-Hall).

**Much information on these rates can be secured from "Cost and Production Handbook" (Ronald Press).

Here the equipment will pay for itself in a little over 1½ years.

2. Relative desirability of two or three machines proposed for the same operation.

For example: In order to secure a production of 4,000 units in a given case, either one turret or two engine lathes may be used.

PROPOSAL A

1 turret lathe, cost $5,000 installed. Requires one operator at 60 cents per hour. Power and supplies, $202 per year.

PROPOSAL B

2 engines lathes, cost $4,000 installed. Requires 2 operators at 70 cents per hour. Power and supplies, $257 per year.

Assume that in both cases machines will operate 2,300 hours per year and will incur the following expenses:

Interest on Investment..... 6%
Depreciation and Obsolescence.10
Taxes and Insurance..... 4
Upkeep 6

COMPARATIVE COSTS

	Turret lathe	*Engine lathes*
Fixed Expense per Year		
Interest	$300	$240
Depreciation and Obsolescence	500	400
Taxes and Insurance..	200	160
Upkeep	300	240
Operating Cost per Year		
Direct Labor	1,380	3,220
Power and Supplies..	202	257
Total Cost	**$2,882**	**$4,517**
Net Saving.....	**$1,635 per Year**	

Floor space savings are not included in the above since they cannot be included unless they will actually be secured.

It can be seen that the turret lathe will pay for itself in about 7½ months, a saving of 41 cents per unit.

3. Replacement of an old machine with a new and better one.

Here the problem of fixed charges must be considered. Decision must be made as to method of computing these fixed charges, as indicated, since it will affect the resulting estimate of production costs.

PRESENT METHOD (Old equipment)

Cost of two machines installed, $7,000.

Estimated life, 10 years—already used 5 years.

Rate of production, 5 pieces per hour per machine.

Two operators at 70 cents per hour required.

Power and supplies exclusive of fixed expense, $210 per machine.

Present scrap value, $800 per machine.

Operates 2,200 hours per year.

PROPOSED METHOD (New equipment)

Cost, installed, $5,000.

Estimated life, 10 years.

Scrap value at end of useful life, estimated at $1,000.

Rate of production, 10 pieces per hour.

Requires one operator at 60 cents per hour.

Power and supplies, $265.

Operates 2,200 hours per year.

FIXED EXPENSES (Both machines)

Interest on Investment..... 6%
Depreciation 10
Taxes and Insurance..... 3

COMPARATIVE COSTS

	New Equipment (1)	New Equipment (2)	Old Equipment (3)	Old Equipment (4)
Basis of Valuation	Installed Cost	Installed Cost Plus Unabsorbed Depreciation of Old Equipment	Scrap Value	Book Value
Value of Equipment.....	$5,000	$6,900	$1,600	$3,500
Fixed Charges				
Interest.....	300	414	96	210
Depreciation....	500	690	160	350
Taxes and Insurance.....	150	207	48	105
Total.....	**$ 950**	**$1,311**	**$ 304**	**$ 665**
Operating Costs				
Direct Labor....	$1,320	$1,320	$3,080	$3,080
Power and Supplies.....	265	265	420	420
Total.....	**1,585**	**1,585**	**3,500**	**3,500**
Total Cost.	**$2,535**	**$2,896**	**$3,804**	**$4,165**
Annual Production.....	22,000	22,000	22,000	22,000
Unit Cost.....	$0.1152	$0.1316	$0.1729	$0.1893

Method 1. If costs for the new equipment are estimated on the basis of a value representing installed cost plus sunk cost (Column 2), and for the old equipment on a basis of scrap value (Column 3), the new equipment will show an annual saving of $908.60. The time required to pay for the equipment is about 5½ years.

Method 2. If, for the new equipment, installed costs are taken (Column 1), and for the old equipment scrap value (Column 3), the new equipment will save $1,269.40 and return its cost in 3 years and 10 months.

Method 3. If installed cost is taken for the new equipment (Column 1), and book value for the old equipment (Column 4), the new equipment will produce annual savings of $1,630.20. Thus it will pay for itself in 3 years and 1 month.

In the last two methods $1,900 of sunk cost must be carried to profit and loss or surplus accounts. Method 1 may be characterized as ultra-conservative; Method 2 as the happy mean; and Method 3 as extremely liberal.

4. Relative desirability of replacing old equipment with identical new equipment.

Here we have the problem of high maintenance costs raising the question of replacement of an old unit with an identical, but new, machine.

For example: If the estimated actual cost of operating a $600 automobile for the seventh year of its life is $404.20 and the equivalent annual cost of a new car is $380.60, it would be advantageous to buy the new car.

WHAT RETURNS?

One point should be emphasized. Before starting any major rearrangement, a statement should be secured from some of the executives in charge of the financial policies as to just what returns they would be interested in. With such a figure definitely in mind it is much easier to go ahead and work out proposals that may meet with approval. Also, the various equipment companies and mechanical-handling concerns are much more willing to put in some time and money on engineering work if they have a definite figure of what type to work toward, than if they have no idea at all whether any proposals they make may be approved. This is not at all hard to understand, because they have been discouraged many times in this depression by going ahead and working out proposals and then being turned down with the statement that nothing would be considered that would not pay for itself in three months or six months.

Of course, in some instances new equipment should not be installed unless it can pay for itself in even such a short period of time. Dean Dexter S. Kimball has made this point clear: "It is not always convenient to include the cost of the new apparatus directly in the cost of production. However, the more special in character the improved apparatus may be, the more care should be taken to include its value directly in the manufacturing cost with which it is concerned. . . . Most items, such as interest, taxes, and so on, are functions of time; that is, they flow continually with the business, and unless disposed of as they arise they accumulate. Hence, in such a case, care should be taken to insure that, over the period of producing life allotted to the equipment, the volume of work that is performed will warrant its installation. . . .

AVOIDING FAILURES

"It is not sufficient that the new machine or method in question can reduce the labor cost on a single operation. There must be sufficient quantity to insure a return upon the investment. This principle holds true for new apparatus, for time-saving methods, for new departments that may be projected, and for the enterprise as a whole. This economic principle is, perhaps, the most important one underlying modern mass production, and a failure to recognize it has been responsible for not a few failures."

BECAUSE plant layout, motion economy, and mechanical handling are so closely interrelated, the reader is referred to these earlier titles in the **Plant Operation Library**

Materials Handling
July, 1935

Motion Economy
November, 1935

•

General reductions in direct labor can be determined from time study standards, if available. If these are not available, certain trial studies in various departments may be made, and the savings determined. Then, with a suitable factor of safety, this ratio may be applied to similar work over the whole operation and totaled to give a final amount in the form of expected savings in direct labor.

In the event that operations are to be duplicated in many similar units, it may be well to set up one unit of each type of equipment according to the proposed layout, and then have accurate studies made under actual operating conditions to give reliable cost figures.

Direct labor savings will be secured through proper grouping of machines, elimination of handling and trucking, and combinations of various operations. One place to look for savings of this sort is in reduced direct labor cost for the operation. Even where time standards have been set by accurate studies, it will often be found that these standards include a certain amount of time in the form of allowances for handling and lifting.

If the new set-up is made properly to eliminate this handling, trucking and lifting, substantial savings should be expected. Savings in direct labor, through proper grouping of machines and elimination of handling operations, may run from 10 to 30 per cent if the layout is properly made.

HARDER TO FIND

Indirect labor savings are naturally harder to determine. Nevertheless, they should be carefully studied. It is here, of course, that a change in the layout from process control to product control will show substantial improvement. As stated before, eliminations in clerical work, records, and forms may be an important item. The emphasis may shift from the functional type of organization to one of line or staff. The method of inspecting may be changed from having all items taken to some central point to inspection right on the job by the operator, or perhaps by having the inspector go to the machine or conveyor and do his checking there.

Many plants are finding it worth while to establish inspection points right along the line of flow, rather than moving all the material to some central inspection point. Unless such a shift is made, many of the advantages of the new layout will be lost, because it will be necessary to slow up the flow of work through the plant to permit such inspection.

Methods of setting tools and machines may be adjusted to the new layout. Not only is new and better supervision required, but methods of making set-ups may also be drastically changed. Full consideration should be given to handling stock, the location of various service supplies, stores, and tools, as well as to methods of machine maintenance.

When completed, the savings figures can be worked out graphically as shown in Figure 18, to indicate a basis for making final decisions.

SELLING THE LAYOUT

Make a complete summary of all savings. All those that can be translated into dollars and cents should be so tabulated. Intangible savings should be listed, if they are important. For example, if a very definite improvement in quality can be secured, or much better control of the operation maintained, such an item should be emphasized. Against this, list all costs of making the move. Work out the return on the investment. Write out a report that contains the facts in a one-page summary.

This summary should be first in the report. Do not make your executives wade through pages of detail in order to discover your final conclusions. Make your statements and then back them up with the facts.

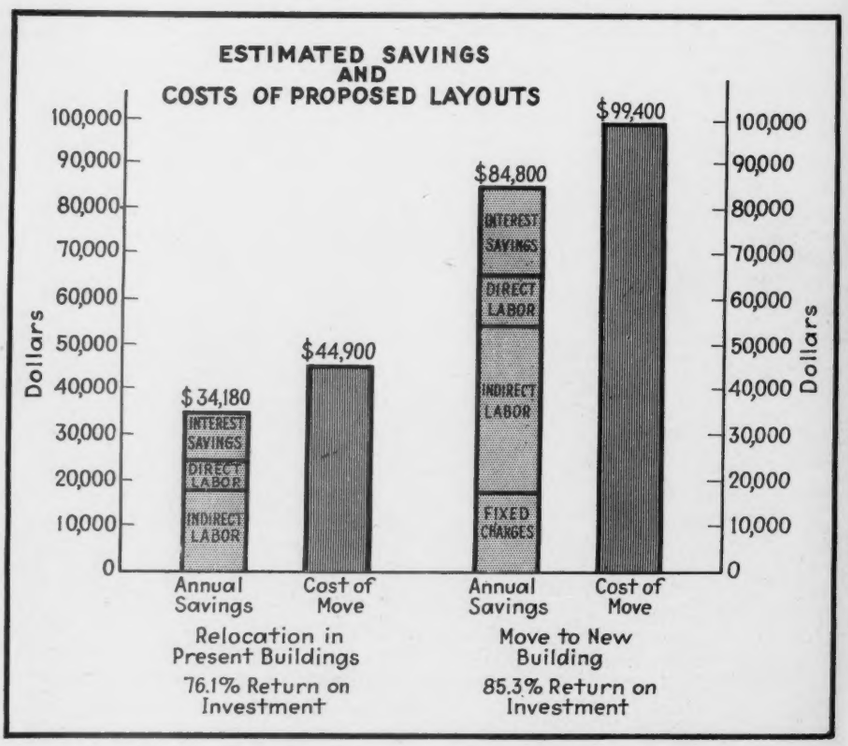
Forget that you are presenting a project for a plant rearrangement. Make a presentation that looks just like a statement of earning possibilities on a new stock issue. Then follow this with your flow process chart, flow diagrams, and all costs and savings.

If there are several possibilities up for consideration, or if the project lends itself to logical divisions, each one should be figured separately on a return basis. When the layout is accepted, a definite plan for moving should be made, each step scheduled, and construction drawings drawn up from the templet layouts.

After the move has been completed, the templet layout should be brought up to date and transferred to a more permanent form. In one plant, all layout boards have been put on a wall in one of the plant offices, where they are instantly available for discussion. Each board is a replica of the one used in the actual layout, but mounted on a clean print and without the string diagram. Each board is covered with Cellophane to keep off the dust.

Thus revisions can be made on the layout board, and plant layout changes from a static thing which it has usually been in the past to a dynamic one. It emphasizes that while we may have the best layout possible today, we are willing to consider a better one tomorrow, if it can be economically justified.

FIGURE 18. Savings figures can be worked out graphically as a basis for final decisions



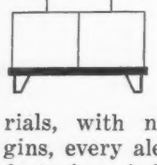
MATERIALS HANDLING

SIXTEENTH IN THE SERIES OF

FACTORY MANAGEMENT and MAINTENANCE

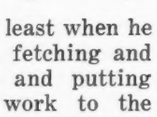
PLANT OPERATION LIBRARY

We're All in the Business of Handling



WITH rising costs of labor and materials, with narrowing profit margins, every alert plant in the manufacturing industries will look to mechanical handling as one of its keenest and most useful cost-cutting tools in the months and years that lie directly ahead. Only by making fullest use of every technological development in production methods and production equipment can *any* plant in *any* industry meet the increasingly rigid requirement of the American economic system.

That requirement—it has been stated and restated in *Factory's* pages—is more goods that can be sold at prices that will enable more people to buy them and enjoy them—in other words, low-cost production in the interest of widest distribution, greatest employment, highest individual net profit.



To have, we must make. Man cannot have what he does not produce. He produces least when he is lifting and hauling, fetching and carrying, picking up and putting down, bringing the work to the machine and taking it away when it is finished. If you don't believe it, take a look at your product and see if all the putting and taking had added a nickel's worth of value to it.

Does the customer who buys an automobile care whether the crankshaft was moved nine or ninety times in its progress from the raw materials stockroom to its final place in the assembled motor?

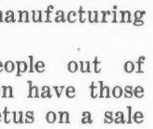
He does *not*. He *does* care, however, about the price he is going to have to pay for that car, and the difference between the ninety times the crankshaft might have been handled by hand and the nine times it actually was handled with the right equipment accounts for part of the reason why he can turn in his 1932 Cyclone next spring and buy the 1937 model. In other words, while handling can never add to the value of the product, the substitution of mechanical for manual handling may be a very potent factor in meeting the requirement of low-cost production.

It meets this requirement by lightening tasks, improving the efficiency of workers; by cutting down the non-productive time of productive workers; by increasing the output both of the man and the machine.

Add to these advantages many others—among them, reduction of process time, of process inventories; regularization of production; positive scheduling; kept delivery dates, satisfied customers—and the marvel of it all is that there still are plants in the manufacturing industries whose handling methods are no better than they were ten, fifteen, twenty years ago.

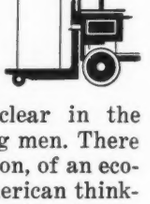
At first blush this failure to take advantage of all that is newest and best in handling methods might appear to be a serious commentary on the intelligence of the average plant operating man. Has not the high cost of handling been "exposed" often enough these fifteen years and more in the pages of the industrial press for him to know handling when he sees it—and, having seen it, to do something about it?

Offhand, yes. Much of this seeming apathy is in no way related to intelligence or its lack, but may be traced to a total misconception of a fundamental principle of industrial economics, and to a laudable, but none the less mistaken, desire to do nothing that will add to the already staggering burden of unemployment.



Perhaps it is this bogey of technological unemployment that has done more these past five years than any one other thing to halt the legitimate progress of mechanical handling in the manufacturing industries.

"But it throws people out of work. . . ." How often have those few words put the quietus on a sale of handling equipment! How often have manufacturers of handling equipment been forced to soft pedal the labor-saving features of their products!

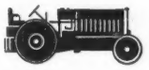


Unfortunately there was a brief panicky period along in 1933 when the answer was not too clear in the minds of plant operating men. There was talk of overproduction, of an economics of scarcity. American thinking was impregnated with doubts raised by the distress of depression. For a while industry was subjected to the notion that it would be fine and dandy if manufacturing production were pegged at a point no greater than existing capacity to produce, and preferably at a point far below that capacity. There was even talk of making it high treason or something for anyone to buy anything in the way of new equipment that could in any way be used to increase factory output or to decrease employment. Industry knows now that the answer lies in the essential economic soundness of the introduction of labor-saving machinery and equipment. There is plenty of evidence that the most highly mechanized industries are the very ones that are today providing the greatest number of jobs, the largest payrolls, and lower-cost goods or services.

Today industry knows that the best guarantee against unemployment is the introduction of more technological improvements. It has only to riffle the pages of industrial history to find proof in plenty that in the long run the machine makes more work for more people.

Eloquent testimony to this fundamental economic truth is to be found in the record of the manufacturing industries from 1870 to 1930—the period of greatest mechanization. In those halcyon days total population increased 3 times; total jobs, 4 times; jobs in the manufacturing industries, 6 times. And that, mind you, was during a *laissez faire* period when technological development was given free rein.

All this is not by way of side stepping the incontrovertible fact that most installations of handling equipment do for the moment deprive men of their jobs. It is not to imply that management has no responsibility in the matter of displacement, that it may calmly announce that some who are here today will be gone tomorrow. Far from it. It is merely to say that management's responsibility is toward the greatest number of employees, that its primary job is to make its products at lower cost so that more people can buy more of them, that in pursuit of that purpose it must make fullest use of every available technological improvement in the machinery and equipment it uses. How else it may hope to survive under today's competitive conditions must remain a complete mystery to anyone who has taken the trouble to think the problem through to its ultimate and inevitable conclusion.



What to do about these people who are thus "freed for other endeavors" is another problem—one of the big unsolved problems that faces industry. Certain it is that it becomes part of management's over-all responsibility to its workers. It is a definite responsibility which management can never duck so long as technological development is to continue—and upon that continuance hangs the future of the manufacturing industries.

Of course there are other good and reasonably sufficient reasons for this apparent apathy on the part of plant operating men towards materials handling. Most potent of them is the fact that handling costs are frequently hidden costs. They lurk insidiously both in indirect and direct payrolls. They are often buried in burden.

Many of these hidden handlings costs are so easy for the experienced observer to spot that again the failure to know them when he sees them and to do something about them after he has seen them would appear to be a reflection on the average plant operating man's grasp of what it's all about.

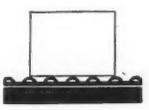
On second thought, it is anything but that. In fact, on looking back over both the editorial and advertising pages of the technical press, it becomes perfectly apparent that the emphasis has been far too much on the what-to-do-about-it, far too little on the how-to-know-it-when-you-see-it aspect of handling costs.

A Common Sense Approach to Handling Costs

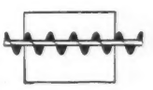
THIRTEEN years ago *Industrial Management's* first materials handling number made its appearance on the American manufacturing scene. In the years that have intervened, that publication and the several others that have been combined to make the present *Factory* have stressed the advantages that accrue from proper use of handling equipment. Article after article has emphasized the need for choosing the right handling equipment for the right job, but no one in all those thirteen years has ever come forward with a sure-fire recognizer that would enable the plant operating man, like the hero of the melodrama, to walk right up to the villain of the piece, unbeard him with one hand, snatch off his blue glasses with the other, and exclaim in a triumphant voice: "I know you. You're Old Man Handling."

Whereupon everyone says why so it is and proceeds at once to do something about it.

That, it would then appear, is what the plant operating man needs most for a proper understanding of the materials handling problem — a common sense approach to handling costs, a simple yardstick which he can apply to his own manufacturing processes, and which will enable him to unbeard and recognize Old Man Handling whenever and wherever the twain shall meet.



If it is, *Factory* has it—a real, common sense approach to handling. It is quite unlike many another "common sense approach" in that it does not presuppose that all plant operating men are specialists in the higher mathematics, with perhaps more than a fair understanding of Einstein's theory of relativity. It is an approach that has never a y in it, and only one x, and that x is merely the designation of a hypothetical manufacturing department. It is the approach to the handling problem suggested by Ralph F. Cohn, secretary and factory manager of the Reynolds Wire Company, Dixon, Ill., in a paper he prepared for a recent meeting of the American Management Association. In this paper he said in part:

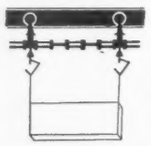


Regardless of the product that you or I may be producing for sale, regardless also of whether we are in a steel mill, a textile mill, or the stock yards, we are all in the handling business, and the chances are pretty good that our handling business would make a poor showing if a set of accounts were available to show just how much money was being spent each year moving goods in process about the plant.

If you think I'm wrong, take the whole or a sizable portion of your plant and list the daily wages of the truckers, elevator operators, crane operators, and others primarily devoting their time to handling. When you think you've finished, you've just gotten a good start. Pick out any ten names at random on the payroll. Spend one hour with each and keep track of how many minutes of each hour each so-called operator is actually moving goods in process, supply materials, or equipment. Such a "sample" should be enough to convince you that you are paying skilled operators a dollar an hour for portions of their time that is either wasted through unnecessary handling or could just as well be done by a 40-cent man.

If this sample of ten men convinces you that you're spending more time handling than you thought, you might next give a time study man the job of

making a similar rough check on all the employees who are directly in contact with the manufacturing operations. Ask him to determine your real total cost of handling. I've a hunch that some layout change will follow. You'll make some simple changes and produce some real savings—but you're not done. Keep the survey at your elbow where it can remind you what a lot of money you are wasting every day. Let it nag you out of the inertia that causes things to "stay put."



Here's an example of what I mean taken from the wire industry. Let's watch a typical department. Two men and a boy shove into the department a load of wire on a cart or truck. The wire drawer lifts a bundle from the truck and places it on a reel. He threads the wire through the wire-drawing die, attaches the wire to the drawhead, and starts the head. Then he walks a few feet to another head which is full of wire, lifts it off the head, places it on another truck. Pretty soon the truck is shoved along to another department. The payroll looks something like this:

Department *X*

Wire drawer — 10 hours at 85c.	$ 8.50
Truckers — 4 hours at 40c.	1.60
Total	$10.10

Now, you're probably not in the wire business and yet you could figure out several different methods that would make the cost sheet look like this:

Department *X*

Wire drawer — 10 hours at 85c.	$ 8.50
Use of handling system	.50
Total	$ 9.00

But I'd rather write it up this way:

Wire drawing — 4 hours at 85c.	$ 3.40
Handling wire by wire drawer 6 hours at 85c.	5.10
Use of handling system	.50
Total	$ 9.00

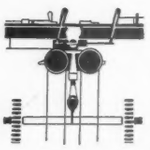
Once we recognize that the wire drawer is more of a put-and-take man than he is a craftsman, we can proceed to make some changes. First we deliver the wire to the wire drawer on hooks or flippers so that he need not handle it from the truck to the reel. Next we give him a welding device to butt weld the ends together so that he can produce heavier coils requiring less frequent removal of wire from the heads. Then we relocate the truck for the finished wire. The job isn't perfect, but the cream of savings has been skimmed. New cost sheet:

Wire drawer—5 hours at 85c.	$ 4.25
Handling wire by wire drawer—1 hour at 85c.	.85
Handling system	.50
Total	$ 5.60

Total unit saving: $10.10 less $5.60 or $4.50.

Thus Mr. Cohn in an approach to handling that is so simple that any plant can use it, so intensely practical that any operating executive will find it profitable to turn a time study man loose on the problem. What he will discover, is anybody's guess. Our guess is that his findings will startle even the oldest inhabitants out of their customary calm and complacency.

Studies may be as simple or as elaborate as you like, in no case more elaborate than the familiar process chart, which is fast coming into its own as the number one tool of the methods man.



To illustrate how the time study man might proceed in his investigations, and to hint at his possible findings, take a typical process chart. A good one for our purpose is the man-and-machine chart shown in the Special Section on Motion Study that was published last November (page S-141). Space limitations forbid its reproduction here. Indeed, since the job is a lengthy one, requiring 103 separate and distinct operations, it was not possible last November to show it in its entirety. However, a large enough sample was presented to give a rough idea, certainly enough to prove the present point.

The point, of course, is that an operator who is being paid something over a dollar an hour, and his helper who is getting around 70 cents, are spending more than a third of their time in handling—which certainly is not as it should be.

It all comes out in the summary, which we shall now examine in detail. Total time for the job is 788 minutes. The machine works 397.5 min., which a little hasty figuring will show to be not quite half the time. There are inspection waits and crane waits that add up to 53 minutes. Another 53 min. must be chalked up to machine repair. The operator walks 6,870 ft.; his helper 3,700. Handling time is 294.5 min. for the former, 309 for the latter.

Handling on this job, in other words which, if not all of one syllable, are readily understood throughout the manufacturing industries, costs something over $5 for the operator's time, more than $3 for his helper's.

The figures are all on the chart. They are repeated here to emphasize the gravity of the situation. Multiply the figures by 10, by 100, and an appalling total may be reached. At least we begin to see how insidious this thing called handling is, how important it is that we recognize the seriousness of the problem.

There is no implication here that much of the handling time in this specific case was unnecessary. We need not go into that. For the moment our interest lies solely in showing that a lot more handling goes on in most plants than most of their operating officials would care to admit. Our only comment on the job under consideration, and it is merely in passing as we move on to succeeding phases of our subject, is that both gentlemen of the process chart were getting rather more exercise on company time than should be required. Also in passing, we stand ready to lay a small wager that most of the exercise and much of the handling time do not appear in the process chart that depicts the job as it is now set up.

It is in the elimination of these wastes, of course, that the true value of such studies lies. Once the studies have been made, the larger job of controlling handling costs is only well begun. Now that we are able to see our handling costs and to know them when we see them, the next thing on the program is to do something about them.

Obviously, in our examination of what we have found, we are going to learn that some of these jobs of handling need never have been done at all; they must be eliminated. Others take too long; distances must be shortened. Still others are not being executed in the most economical way; the right equipment must be found for the job. Last, and most important of all, every plant is still doing plenty of manual handling that could be done far better mechanically—and far more economically. And if that is a strong statement, it is at least a healthy attitude from which to attack the job of getting handling costs down around the vanishing point.

From all this examination of the facts no cut and dried answer will be found for the individual situation. Unhappily it is not quite so

easy as all that. In each case the many *pros* and few *cons* of every major type of handling equipment rate careful consideration. What will it save? How soon will it pay for itself? What changes in product or in process might reasonably be expected that would render the equipment obsolete? And so on and on. The type of equipment is at last selected, and the balance of the job is largely a matter of turning to the advertising pages and consulting with the manufacturers.

All of which latterly discussion is mostly hinting at ways to control the handling problem once you have found it rearing its ugly head in your midst. How to select the right equipment for the job has been the subject of many a dissertation in this journal. Countless articles have shown how other people are doing specific jobs with specific types and makes of equipment. Our job here has been rather to get close to the heart of the problem by describing a simple, common sense approach that will turn up hidden handling costs in any plant that has not appointed a "vice-president" in charge of this particular phase of management endeavor—and in many another that has. How well we have succeeded will be proved by what you turn up in your plant.

Plant Layout and Handling

SO CLOSELY are plant layout and materials handling interrelated that who shall say where the one leaves off and the other begins?

This close tie-up between two necessary functions of modern plant management is one of the more important phenomena of industrial evolution. As plants grew in size, the transportation problem became more and more of a headache. Then it was that mechanical handling was developed to replace the lifting and hauling, the fetching and carrying, the picking up and putting down.

Plant layout in those days was pretty much an open-and-shut proposition—machines located in long, straight lines with generous aisles between them. Aisles had to be wide enough not only to accommodate the steady flow of materials to and from the machines, but also to serve as storage areas for goods in process — storages that were allegedly temporary but too often verged on the permanent.

Management's first inclination, as it took to mechanical handling was to use these aisles. In many instances they were ideal for the mobile types of handling equipment. The power lift truck, the tractor and its train, negotiated their long straight reaches with the greatest of ease. Perhaps it was a natural step to use those same aisles for belt and roller conveyors, for overhead carriers. Certainly it was a mistake to install them without relocating machines.

For instance, a certain department has, let us say, a dozen machines, an operator to each machine. The aisle is nice and wide. A roller conveyor is installed.

A step in the right direction, but only the first, faltering step. The part is heavy. It must be handled from conveyor to machine and back again. The operator spends much of

his time and most of his effort doing something that does not add a nickel's worth to the product.

The obvious solution is to rearrange the machines. That is, it seems obvious to anyone who has given some thought to the major problem of eliminating waste effort. Actually, it must not be so obvious, since management has been so slow in so many instances to catch on.

Let's see what happens in our machining department. All twelve machines are moved, some simply up close to the conveyor, others merely from a north and south to an east to west position. The result is that the conveyor really serves them all. Any one of the operators merely turns in his tracks to transfer the part to the machine or from the machine to the conveyor. And—most important of all—the twelve operators have shrunk to six. Each man runs two machines with less actual expenditure of effort than when he had only one to think about.

By this time it will be observed that our two closely interrelated functions — handling and layout — have taken a third into partnership. Third member of what has now become our triumvirate is motion economy. And what we have so briefly described is one of the simpler phases of the motion economy approach to the problems of layout and handling.*

*For details, see "Plant Layout," a special section of May, 1936, *Factory*.

The technique of this approach has been clearly defined in *Factory* articles dating back over the past five years. It is an engineering approach that begins by analyzing the present method.

Again, as in our common sense approach to handling costs (page S-263), there is no better tool than the process chart. With it, it is possible to follow a part or a product through every step of the process. The resulting flow diagram gives a complete picture of what is going on, at once suggests possible improvements.

For instance, bottlenecks and backtracking stick out like sore thumbs. Just look for converging or criss-cross lines. It may be that the part is taking a long trip to another department in quite another building and back again so that some essential step in the process may be performed. It may be possible—in fact, in a certain case that comes readily to mind because it is described in an article destined for early publication it *was* possible—to install inexpensive equipment right in the line and save that long, useless trip which in itself adds nothing to the value of the product.

That, of course, is the first question that must always be asked. *Can the operation be eliminated?* After it in quick succession follow three other questions. *Can the operation be combined with some other? Can the sequence of operations be changed?* Finally, *can the operation be simplified?*

That is the procedure. If the methods men will assume that every operation is "guilty" until it has proved itself "innocent," he will be in a fair way to acquire the frame of mind so necessary to the successful application of this motion study approach to the twin problems of plant layout and materials handling.

How Goodrich Coordinates Twenty-Five Kinds of

Plant operating men who know their handling plan it as a whole, not as a series of unrelated moving jobs. In presenting typical uses for specific types of equipment, therefore, the customary practice of showing isolated installations—each possibly the best in its class—has been replaced in this special handling presentation by the alternate method of choosing a single plant and showing how it has successfully coordinated most kinds of equipment into a system—a system in the same sense that a great railroad is one. In this way the reader is able to get an over-all picture which he could not hope to get from any other treatment. . . . Ideal for this purpose is The B. F. Goodrich Company. Within its main plant are found some two dozen types of handling equipment. How it has blended them all into a smoothly functioning system will serve as inspiration to plant operating men in many another plant in many another industry

FROM, in 1870, a small brick building at the "other end of the town by the canal basin," The B. F. Goodrich Company has grown to total 116 buildings containing 165 acres of floor space and covering 125 acres of ground. Virtually a city in itself, it maintains its own streets and sidewalks, has its own electric transportation system, a complete cleaning department, police and fire protection, power and heating plants, a refrigerating system, and even a subway whose length rivals that of the Holland tunnel.

Small wonder, then, that the problem of materials handling is one that is undergoing constant study and revision, particularly in the main plant of 51 buildings located on 49½ acres of ground in the heart of downtown Akron. Here, with 120 acres of floor area over which to move both raw materials and finished products, use has been made of practically every type of materials handling equipment.

Changes in manufacturing methods are frequent in the rubber business, prompted by the readiness to apply new techniques as rapidly as they

Handling Equipment

come from the research departments. With these changes in processes, corresponding modifications in materials handling methods and equipment must be made. Goodrich tries to solve these handling problems with as large a proportion of standard equipment as possible for it is recognized that where processes and products are constantly changing, installations that are too specialized will become hopelessly obsolete.

Equipment that can be used subsequently for something else by alteration or transfer is regarded as the most practical as well as the most economical. In other words, an installation of handling equipment must be flexible, as well as adapted to the immediate job in hand.

MORE THAN MERE MOVING

Of course, any selection of equipment presupposes that the economics of the job have been studied, and that savings or necessity will justify the installation. Handling, whether of raw materials or of goods in process of manufacture, is regarded at Goodrich as more than a problem of picking up at one location and laying down at another. Every manufacturing operation, so far as possible, must add to the value of the product at minimum cost, and since the mere act of handling can never of itself add a dollar's worth of value to the product, a strenuous effort has been made to combine, wherever feasible, actual processing operations with handling movements.

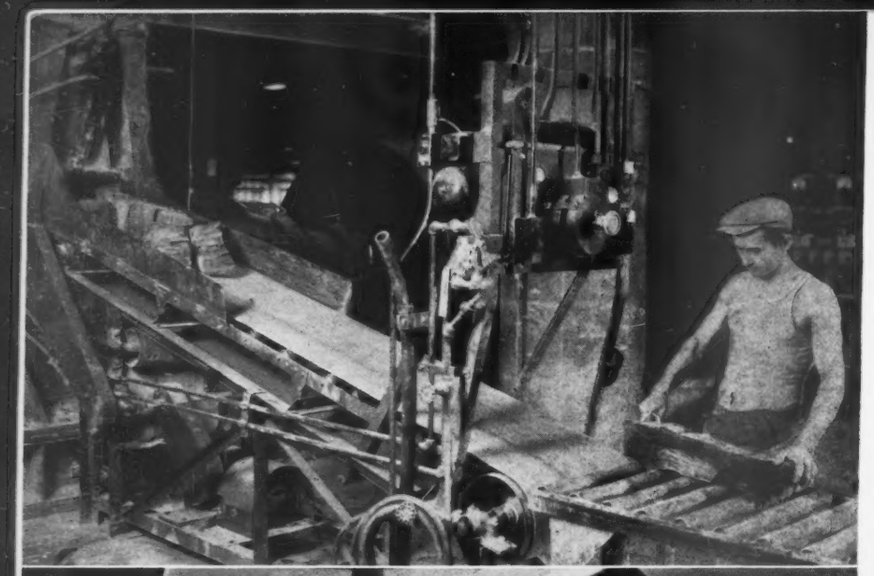
COORDINATION NEEDED

Reverting specifically to the Goodrich plant again, five departments—a Receiving and Warehousing Division (which includes within itself a transportation unit), a Raw Materials Division (which passes on all raw materials received), a Manufacturing Materials Stock Division (which keeps track of inventories to keep the plant running uninterruptedly), and a Finished Goods Warehousing and Shipping Division—must coordinate their materials handling problems to keep order in the receipt and dispatch of the forty or more carloads and truck loads of materials and products going into or out of the plant every day.

Reading from left to right . . . tractor with train of trailers loaded with tires going direct to automobile makers and consequently not wrapped, is just entering the Goodrich subway . . . because soapstone solution with which rubber stock is treated at this point is abrasive to wire cloth or chain joints, V-belt has been substituted on the incline; solution runs off both sides; and stock is discharged to belt conveyor in foreground . . . six slat conveyors in tire curing room handle molds to and from heaters; a hooked strap turned around a capstan supplies the needed pull

•

Above . . . power trucks negotiate freight cars with speed and ease, hence are ideal for moving pigments on skids to automatic elevators (there is one in the background) which in turn deliver loads to any one of eight warehouse floors . . . rolls of tire fabric are electrically hoisted through hatchways from calendering on the floor below and transferred to hook carriers which carry them on the monorail to storage or to processing departments



Crude rubber is scraped and cleaned on the roller conveyor, transferred directly to the power belt that feeds plasticator. Two of these units are now in use; a third is under construction

Wire cloth conveyor carries hot, plasticated stock in ribbon form through chamber where it is cooled by air or water

Belt and chain conveyors are coordinated to handle rubber stock as it is cut to length, hung on four-pronged trolleys, and sent on a three-hour cooling journey. Section of belt beyond knife moves at faster rate to separate pieces, facilitate their pick-up

How the price of crude rubber has altered the problem of its handling is a story in itself. A few years ago practically all plantation rubber was received in mahogany boxes. Later, these boxes were replaced by light plywood containers. When the rubber was worth in the neighborhood of $1.18 a pound a 225-lb. bale deserved such care, and the box was justified. When its price sank to less than 3c., however, not much could be profitably spent on a container. Consequently, a palmetto or woven straw of the kind used for broad-brimmed hats was substituted for the boxes. It, in turn, has been superseded. Bales are now burlap-wrapped and bound with metal bands.

Coincident with these changes in packaging, the rubber bale, which was uniformly cube-shaped and approximately 20 in. on a side, began to take any shape from a thick biscuit to a chunk. As a result manual handling is the only satisfactory unloading method. Any number of unloading devices have been tried, but have failed to overcome the main objection to their use—increased cost.

HANDLING BALES IS COMPLICATED

Goodrich still believes that there may be found a safe, economical type of handling equipment that can adapt itself to the various shapes of crude rubber now encountered, but apparently it has yet to be developed. Further complicating the problem of handling these bales is the need to move some 125 tons (1,000 to 1,200 bales) of the crude rubber a day from the warehouse directly into manufacturing operations, while storing a similar amount.

Fabric is another raw material that has presented a changing handling problem. It used to come in rolls which were approximately 66 in. in width and 36 in. in diameter. To handle these rolls, electric lift trucks were equipped with special scoop-like fronts that permitted several rolls to be hauled at a time. These days, however, by far the greater part of the fabric comes as cord, wound on paper cones or cobs. This change was brought about not only to improve the quality of the finished product, but also to reduce cost.

With the change in manufacturing meth-

Plasticated crude rubber is delivered to the 30 or more mixing mills in cans carried four on a skid; belt in front of operator picks up unabsorbed pigments, re-introduces them between the rolls

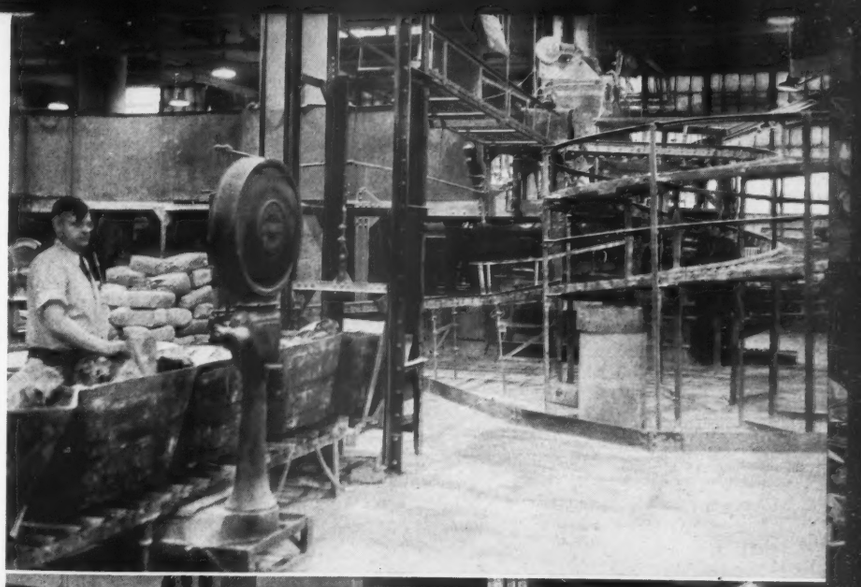
ods, the handling problem has had to undergo a corresponding revision. Whereas with the large rolls the units to be handled were larger and heavier than a man could manage and totaled upwards of 250 a day, there are now 25 to 30 times as many units to handle, but the units are so light that women can handle them. Received in paper bundles—three cones to a bundle—they are tossed out of cars or trucks by hand and taken to storage on skids or in trailers.

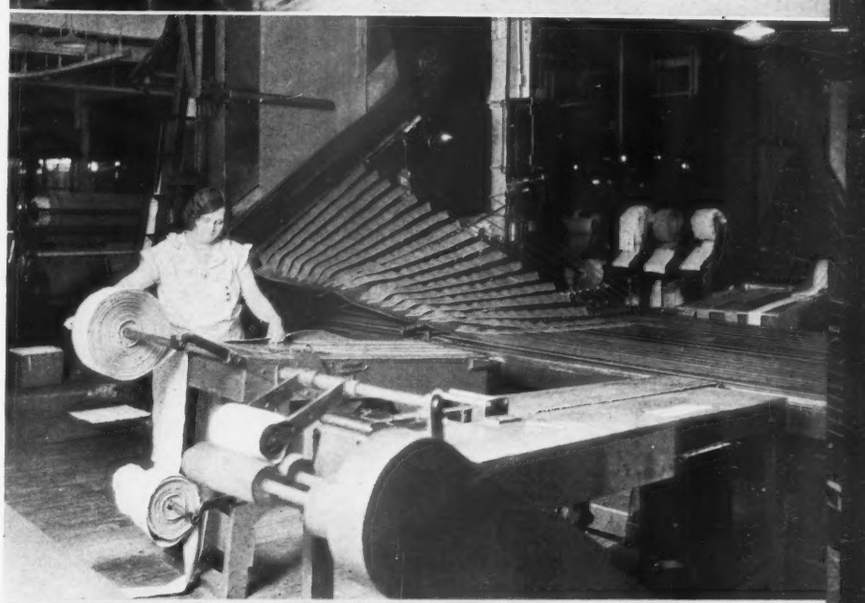
With the equipment now in use, any one of several kinds of fabric can be made, depending on the kind of tire being built. From each creel, as the units are called, a number of fabrics can be made simply by changing the number of cords, or ends, per inch of width of the web. As many as 26 ends per inch are used. On 66-in. wide, 26-end fabric, there are 1,716 ends. As each ball of cord has its tail end tied to the lead end of the adjacent ball, to provide an uninterrupted flow of material, each creel has something over 3,400 balls in storage. Important from a materials handling point of view is that formerly each of the fabrics so produced would have had to be carried in stock as bulky rolls, with the attendant handling problem.

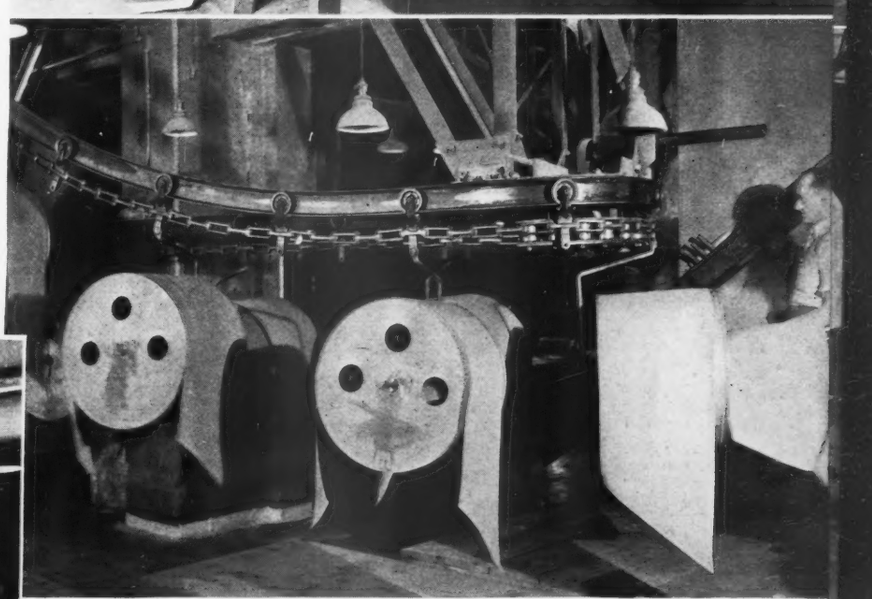
The change from roll fabric to weftless fabric has not only changed the handling of the raw product, but has also eliminated several handling operations. A continuous operation can now be followed in the calendering—where rubber is applied to the fabric. The new calendering procedure ties all these cords together into one continuous sheet which can be rolled, with a liner, into any required length, cut off, and sent directly on into further manufacturing operations.

STAY AWAY FROM SOOT

Rubber goods, however, are by no means all fabric and rubber. Dry pigments and oils are used in large quantities. Carbon black is the most important and most difficult to handle. The material is so finely divided, light, and penetrating that the paper bags it comes in always have a little on their outside. Plain, ordinary soot from the incomplete combustion of natural gas against a cold surface, it is good stuff to stay away from—





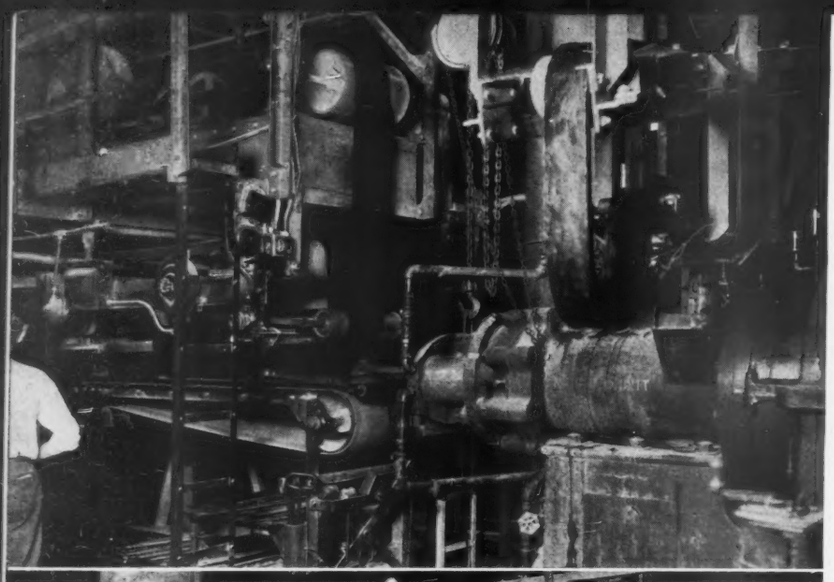


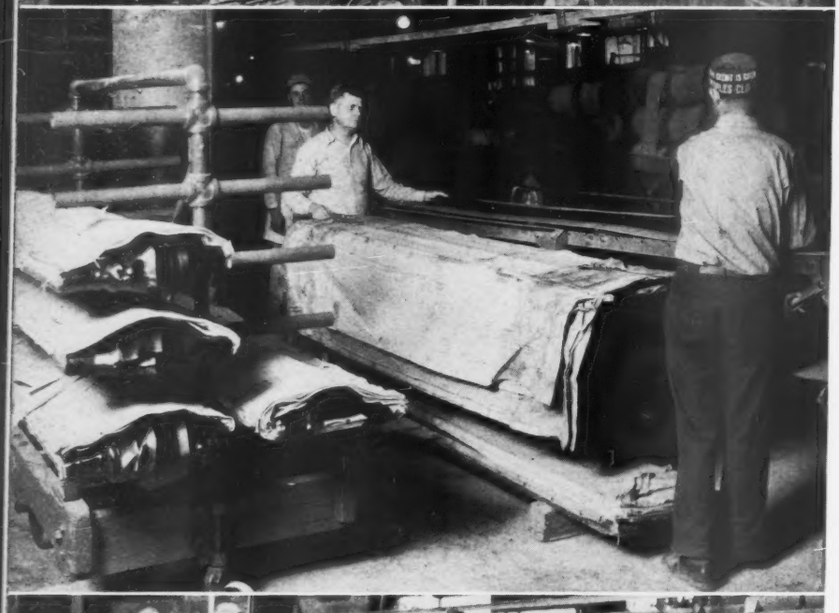
Drums of oil, four on a skid, are emptied with help of electric hoist into steam-jacketed kettles. Pipe lines lead from latter to Banbury mixers

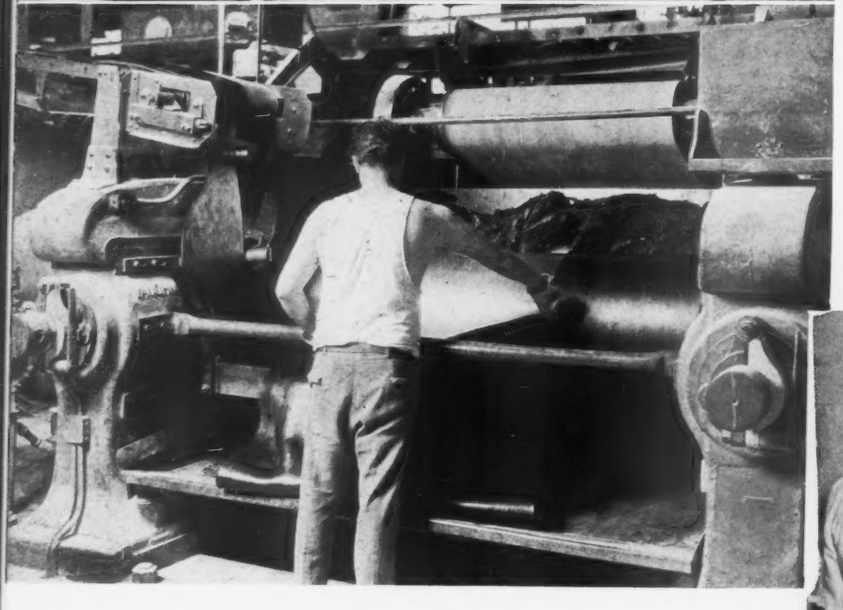
Materials received on skids from plasticators or warehouse are weighed into cans, move on roller conveyors to check scales, are then air-hoisted to level of mixers. Cans return via spiral

From the bias cutter, strips of fabric come on round belts to an apron conveyor that travels along a long table. Operators on either side join alternate ends of strips to form continuous piece of liner

Drum-type carriers permit easy removal of fabric strips from chain conveyors as they pass tire machines







Tread stock is fed into this tube machine by strip conveyor. As tread leaves die, it is stretched to proper cross-section and weight, then moves overhead to 140-ft. cooling conveyor. Speeds are controlled either by adjustable speed drives or by dancer rolls and thyratron-controlled d.c. motors

Treads are delivered by belt conveyors, placed in "books," and handled to tire machines on special floor trucks

Stock comes in chunks from Banbury mixer to mills, moves in a strip via belt (at left) to other mills where operation is completed

and yet essential in making tough rubber. Until recently it could be handled only in bags—which, incidentally, were whisked away by a pneumatic conveyor as they were emptied—as it arched over when stored in tanks or bins. It is now being supplied in small spheres about the size of fine bird shot.

This new form does not arch over and will flow freely through a pipe, which permits handling in tank cars and transfer to tank storage via screw conveyors. Ultimately it is expected to cause no more trouble in handling than do the oils now received in tank cars.

Countless other materials go into the preparation of rubber to give it the required properties for the many uses to which it is put. These materials include zinc oxide, sulphur, mineral rubber, asphaltum, whiting, pitch, tar, wax, oils, soap, coloring agents, and a variety of accelerators and age resistors. Most of them are received in bags, sacks, or drums, handled on skids, and warehoused.

Some of the oils, softeners, and greases used in compounding are received in tank cars, from which they are unloaded into 100-gal. drums. Although it would be more economical to store as carload lots, and perhaps these materials will some day be handled in this fashion, the actual savings in amounts large enough to justify the expense are, so Goodrich insists, difficult to find and prove.

Here again skids are used to store the drums, which are then taken to the various oil rooms as required. Many of these pigments—anything but fabric, whether it be gas black or gasoline, is called a pigment—must be melted before being used.

ADAPTABILITY FIRST

At one time a great deal of rubber cement and high-test gasoline was used in making tires. This is no longer true so a third of a mile of perfectly good solvent lines are now practically idle. They constitute another prime example of a materials handling installation that paid for itself many times over, but was ultimately superseded as a manufacturing process changed. They also serve to illustrate the point that equipment should be chosen, wherever practical, that can be adapted later to some other handling job.

As the Goodrich plant grew, it became ob-

Compounding miscellaneous stocks. Pigments are weighed, placed in cans which are pushed along roller conveyor to point where crude rubber is added

vious that an effective intercommunication system would have to be developed between departments, so the basements of practically all the buildings were connected to a central tunnel or subway running the length of the plant, with supplementary access to buildings by way of bridges between upper floors. The tunnel is 14 ft. wide and has a headroom of 7½ ft. under the plant piping for which the ceiling makes an admirable run.

It affords a clear avenue for rapid transportation throughout the factory, unhindered by the need for passing through manufacturing areas. Being spacious it affords ample room, too, for parking trailers while a train is being made up.

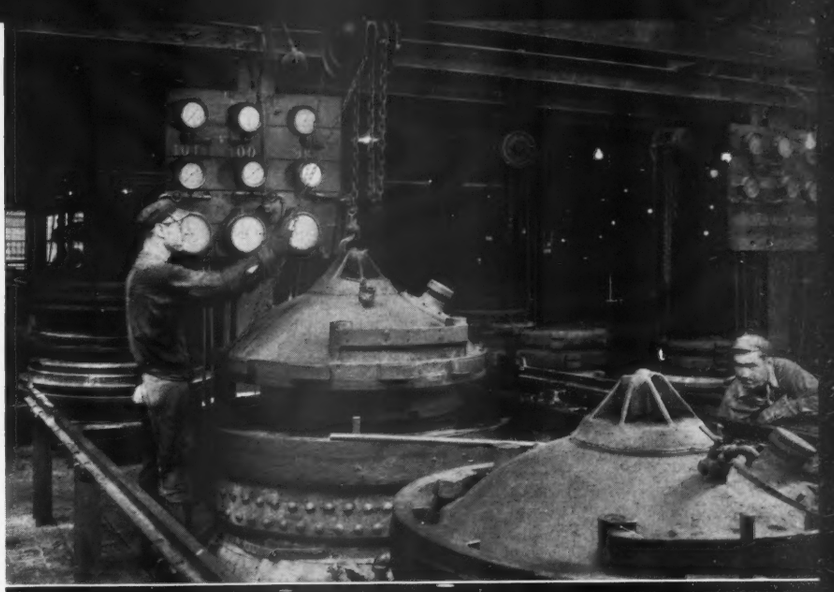
GOODRICH SUBWAY

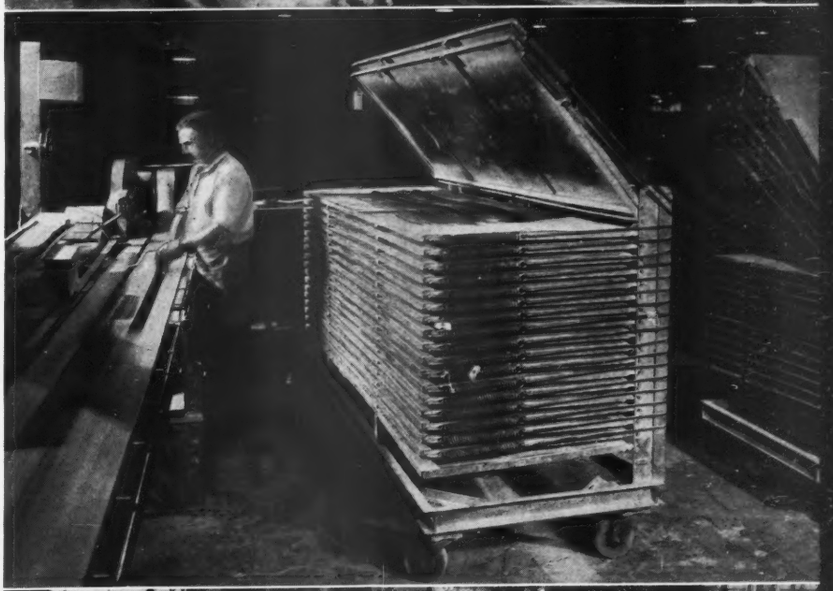
Through these tunnels, in the plant yard, and up and down some 50 or more freight elevators, a large fleet of electric and gasoline lift trucks and tractors handles an immense volume of goods. Some 13,500 skid boards and 2,000 wheeled trailers are used to handle all materials to and from the manufacturing processes. To adapt skids more specifically to the materials being handled, many changes have been made not only in the skid board itself but in the superstructure as well. Racks, bins, shelves, dust-tight cupboards, tanks, and even machines have been built on skids as the particular occasion required.

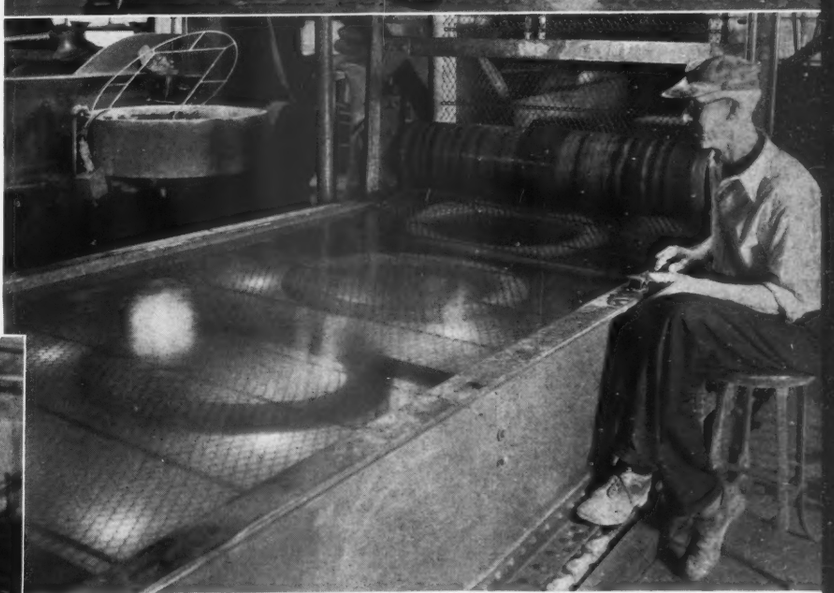
Tractors and power lift trucks have their separate fields of usefulness in the Goodrich plant. Long hauls and pick-ups are made by tractors with trailers. Of necessity, all skid handling must be done by lift trucks, whether hand or electric. Hand trucks are used mostly within a single manufacturing department—for example, to handle batch stock out of nearby storage. Power trucks are used for speeding deliveries from one department to another, for unloading and loading cars, and for stacking loaded skids in warehouses.

All tractors and power trucks are owned and operated by the Transportation Department. This department has its regular routes throughout the buildings, its schedules, and its dispatchers, and successfully keeps pay loads going and coming.

One of the necessary evils of a rubber processing plant is the sticky nature of uncured







Chain hoist is used here as a safeguard to hold rather than to raise the heavy vulcanizer lid, which might otherwise slide off as the pile of molds is lifted by an internal hydraulic ram

Belt conveyor receives inner tubes as they are extruded. At end of conveyor they are cut to length, checked for weight, and loaded into leaf trucks for storage. Spring on each leaf holds it up as the leaves above it are opened

Wire-fabric belt conveys inner tubes through water-filled tank illuminated from below. Up to 28,000 tubes a day are thus tested

Overhead chain conveyors with various kinds of hooks are used to handle green tires from building machines through processes and finally to finishing

Rubber hose, made and cured on the floor above, is blown off mandrels by compressed air, feeds slowly down this chute to the unwrapping bench over at the right

Traveling crane in rubber-covered roll and metals department handles large tanks, pipe, chemical vessels, and 20-ton paper mill rolls through processing and to vulcanizing cars

Tiering machine stacks rolls of fabric in the warehouse, where storage areas are large and all available space must be utilized.

rubber itself. The stock must be sticky so that it will adhere to itself and permit various shapes and articles to be fashioned from it. This stickiness, however, introduces problems in handling and storing, and makes it necessary to so wrap the stock that gum does not come in contact with gum.

To accomplish this protection, cloth is used as a wrapper. This adds to a 250-yd. roll of tire fabric, for example, an additional 250 yds. or more of liner material. All of which, of course, substantially complicates the handling problem since the liner alone weighs in the neighborhood of 300 lb., and must be rehandled separately in returning to the calender room after the tire fabric has been run off in production.

The first process that rubber goes through is plasticizing where the crude rubber is plasticized between heavy rolls or in special extruding machines to facilitate subsequent combining with compounding agents and working in intermediate processes.

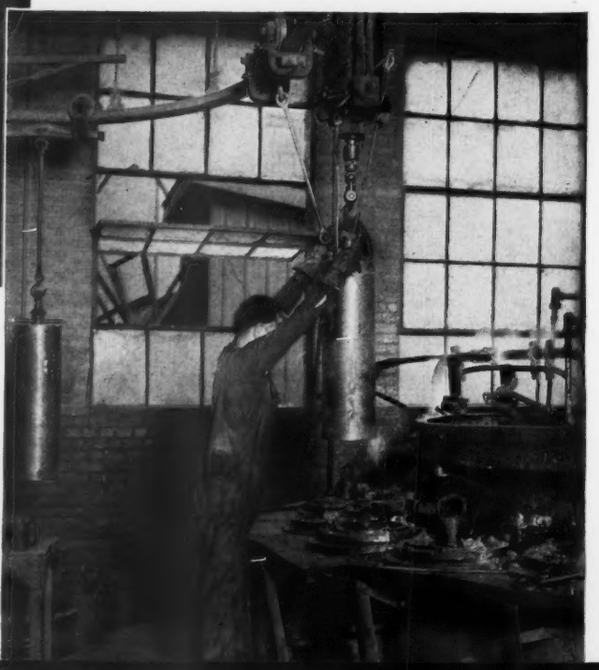
WILD RUBBER IS WASHED

Before rubber was produced on plantations where supervision could be exercised to keep it clean, the bales of crude rubber had to be washed prior to entering the manufacturing process. Usually only wild rubber and the poorer grades of the plantation product are cleaned today, although where special cleanliness is required even the highest grades must be washed.

The washer consists of a pair of corrugated rolls between which the crude rubber is roughly sheeted under a stream of cold water. Wetting the rubber reduces its stickiness and loosens the dirt. Successive trips between rolls set closer and closer together expose new surfaces and eventually remove all the dirt. Skid boards with special arm racks are used to carry the woven-wire trays containing the clean, wet rubber to the driers.

Hung in sheets on rods in a room through which hot air with humidity controlled is blown, or laid on trays and dried under reduced air pressure in a steel-walled, vacuum-exhausted compartment fitted with steam-heated plates, or dried by blowing air over

Pneumatic hoist is used to strip 1,000-lb. lead ingots from molds for use in lead extrusion presses. Lead is used to form sheath about uncured hose to mold it into shape during vulcanization



it that contains about a third the moisture of a fully saturated atmosphere, the rubber emerges ready for the first manufacturing step. Depending on the drying method used, the properties of the rubber can be widely varied.

Every rubber product, of which Goodrich makes some 32,000, requires a specially-compounded mix or batch, as well as special methods of preparation and of manufacture. The many ingredients making up a particular rubber compound are carefully weighed into cans and sent to mixing mills, or Banburys, where they are fed into the rubber as it is squeezed between rolls. After the rubber is soft and plastic, other materials used in the compound are added, and the mixing operation is continued until all ingredients are thoroughly massed and traveling in a sheet around the roll.

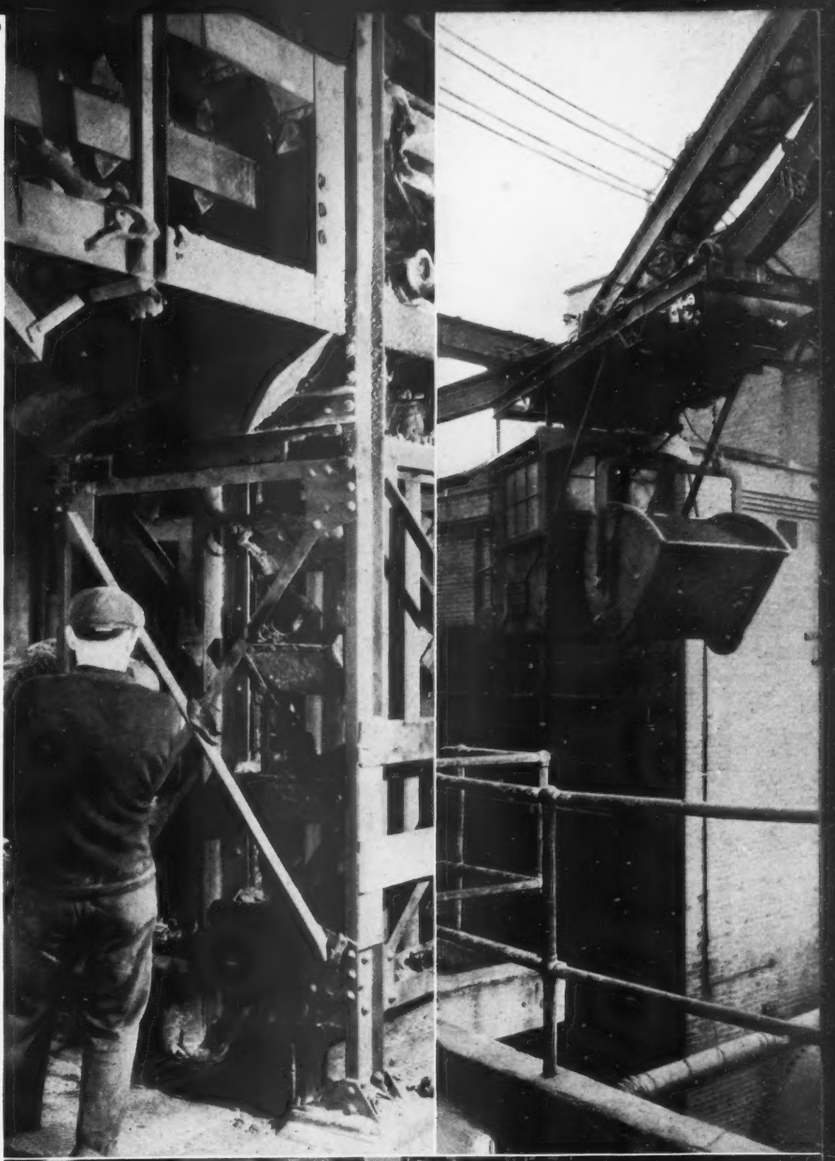
TO PROCESS VIA BELT CONVEYOR

Final operation in the mixing is cutting off in 3- by 6-ft. slabs which are dipped in soapstone to minimize sticking and passed along to the next process. At this point a variety of belt conveyors, used to feed calendering or extruding machines, have been developed and applied throughout the Goodrich plant.

Calendering or extruding machines are used for forming rubber mixtures preparatory to their going into one or another fabricating department. Fed through a calender, for example, the rubber may emerge as a finished sheet or strip or may be combined with a fabric into which the rubber has been impregnated to form an inseparable part. Extruding machines are used primarily where the finished rubber takes a shape—such as tire tread, automobile window strip, or molded goods stock.

Calendering machines vary in size. Those used to prepare material for rubber shoe soles and uppers, for example, are small. Those used in rubberizing fabric are large enough to accommodate sheets 60 to 90 in. wide. The materials handling problems caused by these calendering operations are as specialized as are the products being produced.

Final manufacturing steps in making rub-



Chain-driven apron conveyor in reclaiming plant brings de-vulcanized "cake" from drier to screw conveyor which processes it somewhat and delivers it to dolly cars or chutes that discharge to batch pans

Some 25 varieties of bucket elevator are used in the rubber reclaiming department. This one is carrying tire carcass from choppers to grinders

Telpher conveyor moves materials from one part of reclaim plant to another. Car can be dumped from cab or set down on wheels

Screw conveyor dumps batch through slide gate to dolly car. Electric lift truck is equipped not only to carry dolly car but also to tilt it to dump on floor or into hoppers

Reclaimed rubber adds certain desirable characteristics, is used regardless of price as a compounding ingredient, not as a substitute for crude, which at one time was actually cheaper. Gantry cranes cover a lot of territory, enable piling at great heights

Eighteen tractors are used to haul trailer trains about the Goodrich plant. Paved yards facilitate movements of materials

Finished casings come into the warehouse on conveyors for sorting by size and brand. Trucks flank the conveyor line, carry the tires to wrapping machines, to storage, or to shipping platforms

ber goods vary widely. Some articles, such as heels and hot water bottles, are formed by pressing unvulcanized rubber compounds into hot molds, which then go to vulcanizers. Other products, such as tires, tubes, and hose, are built up by hand or machine from sheets of unvulcanized compound, fabric, and other materials, and are then pressed into hot molds for curing.

OVERHEAD CARRIERS

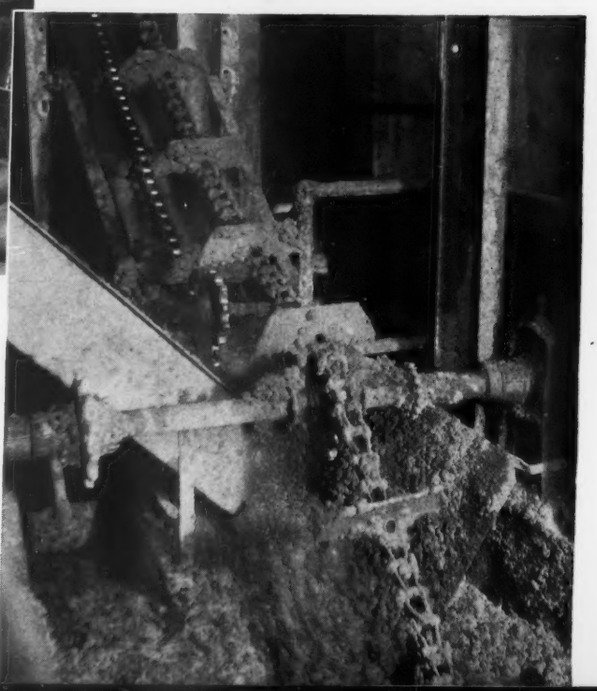
To mention specific handling jobs, an overhead track system has been found most satisfactory to carry rolls of fabric and liner from the calendering machines to storage where they are set on racks to age or cool before being cut up into tire plies. The carriers are arranged with a hook and a yoke that has a hinged double eye. This latter is used to transfer the yoke from an electric hoist to the carrier hook, and from the carrier hook to a chain hoist to move to and from the storage rack.

It seemed at first that the storage racks might better be eliminated by storing entirely on the rail, but a more detailed analysis of the problem determined otherwise. Carriers are expensive. In addition, the supervision of the movement of rolls into and out of storage takes the full-time services of a stock man anyway who could just as well handle the raising and lowering of the loads. An added disadvantage of rail storage was the inability to get at a particular roll in the middle of a loaded rail without moving all the carriers between it and the front of the line. Storage on the racks, on the other hand, makes any roll readily accessible without moving adjacent ones.

From storage, fabric goes to the bias cutters where it is cut to proper widths for tire construction. For some tires the ends of these widths are stuck together and the strip thus formed is wrapped into liners which are taken to the tire machines on skids or trucks developed especially for the purpose.

Other bias fabrics go more directly to the tire machines on a chain conveyor. This conveyor is special only in the design of the car-

Some 15 flight conveyors carry "mud" around the reclaiming plant. They are easy to keep clean, have no tendency to knead the material



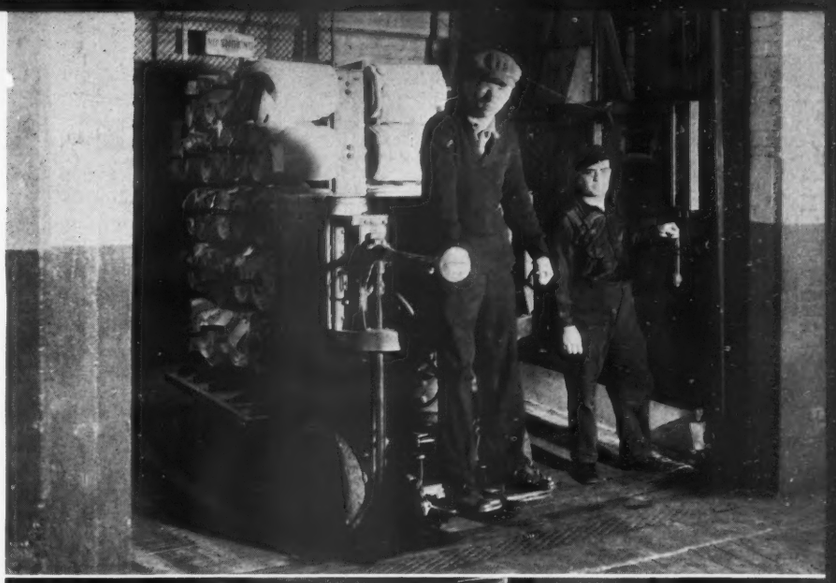
riers, the chain track and drive having been once used in another department on another kind of handling problem. It eliminates all handling to the tire machines and wrapping into liners. The speed is adjustable and is timed to be fast enough that too long a wait is not made by the last man on the line to be passed. About 20 per cent of the hooks are full after passing the last tire-making machine.

Batch stock is carried on skids to the tread department where it is warmed into a plastic mass on a mill and finally leaves in a strip to feed extruding machines that make the tread sections. For many years, instead of a strip coming continuously from the mill the whole batch was cut off and rolled into liners. This was then taken to the extruders and the stock cut into strips and fed by hand. However, the demand for a better balanced tire made the hand feed impractical, because it was impossible to get uniform extrusion of the tread section.

WHEN THE PRODUCT CHANGED

The solution of this problem lead to the solution of a handling problem, with accompanying savings as well as improved quality. Early in the era of hand-fed extrusion machines a double-strand chain conveyor with the strands set about 12 ft. apart was used. Between were carriers for receiving books of treads (reinforced boards with fabric leaves between which the treads are placed). The conveyor had several stations or dips on the first floor of the plant, then rose to the sixth floor, returning on the opposite side of the building.

This arrangement worked well until changes in tire-building methods rendered it impractical. The conveyor has been replaced by specially designed trucks, which have been most satisfactory. This revision of handling methods again emphasizes the point that while a product is undergoing rapid changes in method of manufacture, design, or quantities of production, it is hazardous as well as difficult to say just how far to go in the design of handling or processing equipment.



Jib crane with 1-ton hoist handles rough mold castings out in the yard, makes a one-man job out of the backbreaking task of loading and unloading

More than 12,000 skids are in active use for transportation and storage purposes at the Goodrich plant, many of them equipped with special racks designed to hold specific kinds of material

Hand lift trucks are used throughout the plant for short hauls within departments, provide economical transportation for that kind of service. The metal-topped wooden skid is being rapidly replaced by the all-metal type shown in the background

For a big plant, a big coal pile. Goodrich's is served economically and well by an electric locomotive crane

In the tire-building department numerous overhead chain conveyors handle green and cured tires. One goes between the rows of tire machines to take the flat green tire to a transfer point from which it can be dispatched for further processing or to storage. The length that this type of conveyor can be operated makes it particularly valuable, as it permits operations to be spread out to the physical limitations of the buildings and insures profitable use of all available floor space. After the product is once on the conveyor, distance makes little difference.

Some of these chain conveyors are over 1,700 ft. long. Most of them have been in service a long time. Many have been relocated several times and rearranged to suit changing conditions in process and product. They have survived the changes from fabric to cord construction, from core-built to flat-band methods, from high-pressure to balloon design and the larger cross-sections now used. More changes have been made in the design of the hooks than in anything else.

Carried on this type of conveyor the tire goes through inspection, soapstoning, and forming until it gets to the curing department, where it is put into steel molds and cured.

Slat conveyors in the heater rooms are arranged to form rectangles around rows of vulcanizers. As long as the mold stays in the run it is not necessary to lift either lid or bottom. The discharge conveyor at one side of the rectangle is slightly lower than the lip of the heater so that molds can be pulled on it with a hooked strap caught into the mold and turned around a capstan. Another slat conveyor feeds the molds into the heaters over a portable bridge and deflector. The feed conveyor, on the other hand, is a little higher than the lip of the heater, so that gravity may be used to get the molds into place.

After curing, the tires are placed on a hook conveyor which, after getting to the proper location in the building, makes a vertical run to the sixth floor where it automatically dumps tires for final finishing and inspection. As two of these units are required to handle the volume, the conveyor dumps half at one unit, half at the other. The dumping operation is so controlled that the tires fall on edge on a belt conveyor. At stations along this conveyor they are trimmed, painted, decorated, and finally inspected.

It will be seen from the accompanying photographs that many processes in rubber manufacture are carried out on conveyor belts. One application is in making miscellaneous automotive inner tubes. This belt has a special bare fabric cover to which the uncured gum will not stick. Tubes are extruded and cut to length on this conveyor. They are then stored in leaf trucks to be later spliced and cured according to schedule.

Formerly these tubes were booked much the same as treads are. These trucks can be handled by one man, whereas generally two were required to handle the book onto a book truck. The increased capacity of the leaf truck has also done much to relieve congestion in storage areas. However, this relief will be short-lived, for to accommodate a change in product and process every other leaf in these trucks is being removed. The change would have been altogether impossible with book storage.

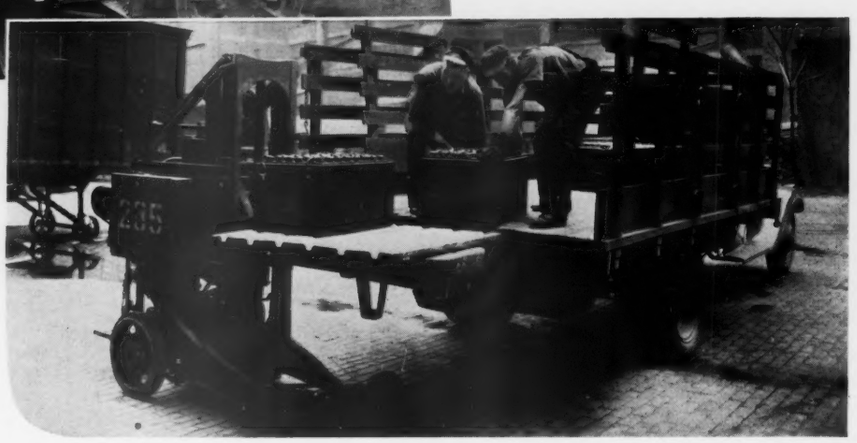
Of the many pieces of handling equipment in daily use at Goodrich the most universal are, of course, the skid boards, with power trucks and tractors a close second and third. Overhead chain conveyors for transporting loads and belt conveyors for carrying them through processing operations are in their applications more highly specialized, and must be planned and installed with due consideration for the changes in process and product that will have to be accommodated. Fitted into the complete picture are some two dozen other kinds of mechanical handling equipment, each chosen as best suited to do a specific job. The result is what might truly be termed a "system" in the same sense that we apply that term to a great railroad. Only to the extent that industry is able to plan its handling as a whole and not as a series of totally unrelated moving jobs will it be able to control this increasingly important item of product cost.

•

For the motion economist's approach to the twin problems of materials handling and plant layout, turn to these earlier special sections of *Factory:*

Motion Economy
November, 1935
Plant Layout
June, 1936

•

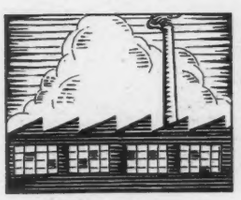


Electric high-lift truck is powered by batteries similar to those it is helping to unload

Electric low-lift truck transports a large tire mold to storage on the ubiquitous skid

SAFETY

AUTHOR
TOM A. BURKE
National Safety Council



SEVENTEENTH IN THE SERIES OF

FACTORY MANAGEMENT and MAINTENANCE

PLANT OPERATION LIBRARY

CHAPTER ONE

Guards Plus Education

THE IDEAL in industrial safety is possible of attainment only when plants, fully guarded mechanically, are operated by men trained to do their jobs safely. This is not altogether a dream of an industrial Utopia. There are many plants today that hold their accident rates down pretty close to the irreducible minimum and do so consistently.

As time is measured, the industrial safety movement is still in its infancy. Yet much has been accomplished during the 24 years since a little group of industrial engineers organized the National Safety Council in Milwaukee. Mechanical safeguarding has reached a high plane of efficiency; educational work backed by supervision and disciplinary control has become literally a part of production.

SOME OUTSTANDING RECORDS

Nearly four thousand members of the National Safety Council, representing 30 major industries, show in their 1935 reports a 61 per cent reduction in the all-industry frequency rate since 1926 and a 43 per cent reduction in the severity rate. Also there was a 10 per cent frequency drop and an 11 per cent severity reduction as compared with 1934. That of course shows a most wholesome trend and may be taken as a pretty fair cross-section of safety work in American industry.

But also many outstanding individual records have been made during recent years in departments and small units, and also by many entire plants, such as Western Clock Company, LaSalle, Ill., which amassed a total of 11,114,600 safe man-hours without a lost-time accident; E. I. du Pont de Nemours & Company, Old Hickory, Tenn., with 9,116,634 man-hours; United Shoe Machinery Corporation, Beverly, Mass., 8,472,248 man-hours; Raytheon Production Company, Newton, Mass., with 7,243,532 man-hours; Clark Thread Company, Newark, N. J., with 6,972,695 man-hours; Remington Typewriter Company, Syracuse, with 6,145,514 man-hours. Several others completed more than 5,000,000 safe man-hours before their records were terminated by lost-time mishaps.

Each of these achievements is a story in itself, a story of safety organization, continuous educational effort, mechanical safeguarding, and last but not least, *cooperation*. Incidentally these are all-time safety records among Council members.

But one of the most interesting developments to those who have followed the colorful chapters in the growth of industrial safety has been the changing attitude of management—running a cycle from rather disinterested tolerance in the early days to active, wholehearted interest and support at the present time. To illustrate:

An additional mill was planned recently for one of the units of a big steel company. Before work started the plans were sent to the safety department for approval. A check-up showed a 14-in. clearance between a certain machine and a pillar support. The safety department requested a 20-in. minimum clearance and greater if possible. It was found that such a change would mean practically redesigning the mill building and would increase the cost around $50,000. The plans and the "argument" finally went to the plant manager who simply wrote a brief pencil note to this effect: "If the safety department says a greater clearance is necessary, it should be made regardless of the cost."

Such confidence is not misplaced. It makes possible the building of safety at sources; planning ahead in layouts, in building new machinery, in constructing new units.

Machine guarding, of course, was safety's afterthought. Necessity is, as always, the mother of invention. Before we thought about guarding machines, we saw plenty of mangled hands and arms. Men had eyes gouged out by flying bits of steel or lost their sight in acid splashes before anyone thought of goggles. We had the crushed toes first, then safety shoes.

In many plants today the mechanical ingenuity of the employees leads to the invention and installation of satisfactory safeguards such as protection for power press operators, guards for power transmission apparatus or exposed gears.

Also, mechanical safeguards are often built in at the time machinery is manufactured. Doubtless all hazardous machinery will one day be manufactured with every possible protective device built in as a part of the job.

LIGHT AND HOUSEKEEPING

The matter of mechanical safeguarding is, after all, only a part of the *external*—the physical or mechanical side of safety. Amazing progress has been made in illumination, because management realizes, as never before, the value of the right kind of light, properly diffused and focused. Good ventilation, too, has a direct bearing on hazards, for without it there is fatigue and mental dullness, danger to health.

There is the matter of good housekeeping, too, a fundamental in the industrial safety program. Closely related is the problem of sanitation, also first aid. Tools must be safeguarded and kept in repair; floors kept dry and unobstructed. Stairways must be built for safety nowadays with definite standards in height, width, and rise.

When both hands must be used in tripping, fingers never get caught in the press. Gloves protect against sharp edges and splinters

They must be well lighted and kept clear for use. Consider, too, the matter of proper chairs, stools, and work benches. Designs are worked out by experts today, which make working operations easy and comfortable and promote health and safety. Incidental but important things include the clear marking of traffic lanes and lines, well-marked and guarded intersections, and signal systems—in fact, the whole plant layout.

In the ideal plant these physical, mechanical things have already been done because they are basic. We must have the suit before we can sew on the buttons. Mechanical safeguarding has to come first. Only after that can education be made really effective. Without education and job training no amount of mechanical safeguarding will keep men from maiming themselves or others.

Let us assume, then, that a fair share of our plants today have provided their workers with reasonable mechanical safeguards, with safe wearing apparel, goggles and safety shoes, with respiratory and other equipment. In addition, a more or less standardized educational program has been carried out for years. Accident rates have been cut, way down—as 1935 figures show. Energetic safety departments have kept pounding away without let-up. Safe practices have been pointed out to workers over and over again and unsafe working methods detected and tabooed.

Now isn't it natural that there should be a tendency toward let-down? Why shouldn't interest lag after a time? Posters, bulletins, safety meetings, and other routine educational methods—necessary as they are—must be stimulated. Athletes grow "stale" and lose their contests if they train too long. Isn't it reasonable to assume, then, that workers — and even the safety supervisors—should get a little weary of the never-ending war on accidents?

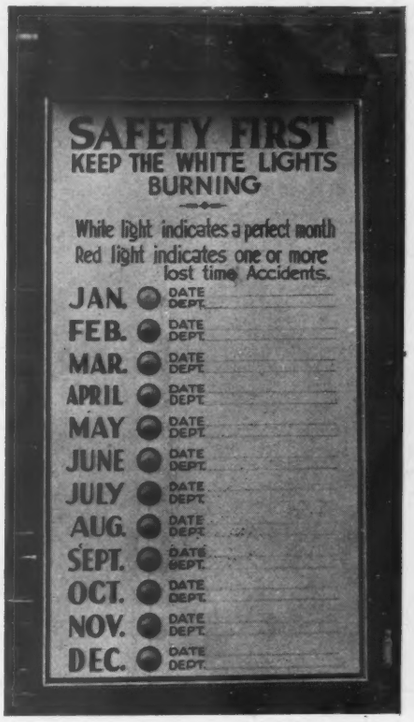
As we approach the completion of a quarter of a century of safety work in industry we wonder, naturally, what new ideas can be brought into our programs to stimulate greater interest and efficiency.

There are probably many hundreds of thousands of old-time employees working today who were on the job when the safety idea was born. They have literally grown up with the movement. They are the backbone of industry, men whose working technique is admired and copied by new and younger members. There is a certain amount of hero worship in the shops, just as elsewhere. Usually it is based on skill—an expert working technique which is the envy of less efficient men.

KEEP THE PROGRAM FRESH

These older men, usually safe workers, carry great influence with others in the gang. Their enthusiasm must be kept up. If they get tired of oft-repeated safety injunctions, so will the younger men; if they scoff, the derision will be echoed among others. They have usually held the first-line trenches in the war on accidents.

Men weary of repetition, regardless of its nature. Alert plant operators have sensed this in their safety programs and are already doing something about it. Safety morale is hard to build, but easy to wreck. You can keep men interested in safety just so long as you can keep up their faith in it. The more effective your educational program, the less disciplinary work will have to be done. But educational work, too, must be kept fresh, interesting, appealing. Otherwise much of its effectiveness is lost.



Color, motion, lights—all help dramatize the safety feature, catch attention, make the message stick

CHAPTER TWO

"Face Lifting" for Old Ideas

THERE are many ways of stimulating plant safety programs and keeping up interest and enthusiasm. Some of the ideas are new; others have just been made to *appear* new. In general these stimulating ideas do not depart from the time-tested standard activities which we know will reduce accidents. Rather, they amount to polishing up old ideas—putting the picture in a new frame.

This idea of revamping the old has great possibilities. Take the matter of bulletin boards, for example. They are usually placed at focal points where they can be seen easily by the largest numbers of employees, and of course have tremendous advertising value for safety promotion. So revamp your bulletin board program as a starter. Liven it up; animate it. Change the general design. Put some good mechanics to work getting up a new board. Use moving gadgets, flashing lights. Borrow ideas from modern advertising trends.

Why are the big firms willing to spend hundreds of thousands of dollars a year in outdoor advertising? Simply because it pays. And it pays because the advertisers make it attractive through dramatization—by using special lighting effects, changing colors, motion. The same psychology will sell safety. Work with your maintenance department and turn the matter over to a special committee, possibly offering prizes for best ideas. Remember the bulletin board is the natural "show window" for safety.

Change material often. Today's newspaper is dead tomorrow, you know. Use strong, dramatic posters, changing them as often as you can—every day, if possible. Supplement posters with bulletins, special letters. Liven up everything with important plant news. That is one of the best ways to make a bulletin board popular; make it a sort of daily plant newspaper.

Don't let anyone tell you the poster idea is dead. The National Safety Council publishes annually more than three million posters in more than 600 designs, and they find their way to plant bulletin boards all over the United States and in many foreign countries. The psychology of the poster is sound. The lesson is learned quickly and with not-to-be-forgotten punch.

The gruesome poster or the constructive, positive approach? It is still a moot question. Horror posters are still favored by some plants, although not so much as formerly. The "positive" education advocates hold that gruesome posters are bad for morale; that you cannot frighten men into being cautious; that the only effective education is positive, constructive. They maintain, too, that doses of frightfulness must, like doses of narcotics for pain-killing, be increased constantly to be effective. The horror-type advocates point to the popularity of the pamphlet, "—And Sudden Death" and its influence in helping arouse the American people to the perils of driving—which it did.

Employees should be required to report all injuries, no matter how slight, and have them attended to immediately at the first-aid station

There is a modern school that prefers a happy medium; a little of the gruesome perhaps, even to the point of showing occasional photos of things like infection cases. But they object to going quite as far as some sensational newspapers—whose editors will flaunt sheet-draped public enemy cadavers on their front pages. So take your choice!

In the past, management has all too often followed a policy of keeping behind the scenes in the safety program. In plants making best records today you will find almost invariably that top management takes an active interest in the functioning of safety.

"TOLERATION" ISN'T ENOUGH

In the old days many workers got the idea that management was not particularly interested one way or the other; that safety was just a sort of "side issue." Unfortunately that old "toleration" attitude was true to a certain extent. Some companies took on safety because they were practically forced to do it as a matter of self-defense. Naturally, employers were lukewarm. But that attitude has just about disappeared.

One of the consistently fine industrial safety records has been made by Western Electric, Hawthorne Plant, Chicago. During the past ten years the accident frequency rate was reduced 95 per cent. Those who have watched this program have been impressed with the active interest of management and see in it one of the reasons for this record.

The plant lately announced the use of aluminum pliers instead of steel in punch press operations, the softer material being used purely as a safety precaution. An operator was feeding blanks into a general-use buffing punch and die. While he had his pliers under the ram, presumably to remove the parts just stamped, he accidentally tripped the press. As the ram closed in on the pliers, about an inch of the jaw was crushed off and a chip from the punch, a full quarter-inch in length and an eighth wide, shot into his left eyeball. This worker had a pair of the soft tweezers at the time of the accident but was not using them. He may lose his sight.

QUICK, EFFECTIVE ACTION

Before the facts of this particular accident had been allowed to cool, a special letter from C. L. Rice, Vice-President and Works Manager, appeared in "The Accident Record," a plant safety magazine and left no doubt about management's stand. Excerpts are well worth quoting:

"Not so many days ago one of our fellow workers had an accident—the most serious one we have had at Hawthorne in several years.

"The primary cause, responsibility, corrective measures taken, and all the factors that are part of an investigation made 'after the fact' won't be discussed here.

"The only thing that concerns us is this: One of our fellow men has probably lost the sight of an eye. And you can't replace an eye. . . .

"I know that accidents can be reduced. I know that they can even be eliminated from this plant. In fact, we have done it on several occasions and by working together we can do it again. It's not a one-man job. To reach our goal demands the personal attention and interest of everyone at Hawthorne.

"I don't like to emphasize one man's misfortune in order to illustrate what I have in mind. But in the interest of us all I must say that the difference between steel and aluminum pliers may even mean the difference between blindness and vision for every punch operator in the shop. It is most regrettable that a fellow-worker should lose the sight of an eye. It would be even more regrettable if we failed to learn from his misfortune."

So then a second fundamental of keeping the safety program alive is a more active interest on the part of management, through special messages from time to time, directed to the workers themselves, and through personal appearances before the men at their gatherings. Try to get across to your working force not only what your interest is, but also what your *stand* is, saying in effect: "We want you to work here; we are doing everything *we* can to make your job safe. So you must play ball by doing everything *you* can to prevent accidents."

Isn't such an attitude fair, after all? Is there any need of pussyfooting? Such a stand is of untold value to the working efficiency of the production department where all too often not only workers but also line supervisors fail to lend full cooperation. A frank, uncompromising stand by management is good medicine clear down the line.

There is nothing that will stir up the smouldering flames of safety more than a personal appearance by "the big boss." A five- or ten-minute talk, frank, honest, straightforward, with perhaps just a little bit of dynamite, will work wonders with an anaemic safety *esprit de corps*.

Not far behind personal appearance in value are letters and bulletins sent directly to workers from top management. The National Safety Council publishes four industrial safety magazines, and thousands of plant publications throughout the country emphasize their safety work by giving it generous space.

One hundred and fifty Safe Practices Pamphlets have been issued by the Council as standardized texts for the 30 industrial sections of the organization, touching just about every hazardous occupational pursuit known. Hundreds of thousands of payroll inserts devoted to safety are used by plants all over the country each pay day. Dash-card safety signs are used by hundreds of commercial fleet operators.

THE UNUSUAL IMPRESSES

Safety Rule Books—common for years—have had so much the same general appearance as to style and content that it is rather refreshing to see a slight deviation from the usual cut-and-dried warnings. A new type of printed safety instructions was recently issued by the Morrison-Knudsen Company, Inc., at Boise, Idaho, entitled "Dangerous Spots on Construction Jobs." An eight-page, pocket-sized folder sets forth in novel way the circumstances of actual accidents of the most common type in construction work. The statement of the case is printed in black and there follows immediately in *red* a statement of how the accident could have been avoided. For example, following the brief story

about a man who had gone up the blind side of the shovel-runner and was injured when a crane bucket struck him in the back, appears *in red* the following paragraph:

"Ground men and oilers: For your protection always be sure that the shovel or drag-line operator knows where you are working. His view is sometimes blocked and it is therefore *your* responsibility to let him know where you are, especially if out of the range of his vision."

The value of such a pamphlet is, of course, that it is quite different from the ordinary rule book; the subject matter is presented in a new and interesting way, while the red type emphasizes the importance of safe working practices for each case and points out specifically what should be done.

Why shouldn't safety today be made a part of every worker's job? Certainly a contract of employment gives an employer the basic right to outline the duties he wants performed. It is management's right to select only men who will take safety work seriously and obey all safety rules. More and more industry is making safety a condition precedent to employment—and rightly so.

CHAPTER THREE

New Ways of Reaching the Foreman

THE FOREMAN is the key man in the safety program; on his attitude the work may succeed or fail. It is of utmost importance that his interest and enthusiasm be kept at high pitch, that he accept willingly and wholeheartedly the responsibility for the safety of the men in his department. His is the pivotal, key position. The successful foreman is known, not only for his ability to get the right kind of work done promptly and at low cost, but also by his safety record.

Consider the plan now being carried out by C. M. Allen, safety director for all five plants of the American Rolling Mill Company. In a laudable effort to get closer to the accident problem and to bring it just a little closer to plant supervision, he has started a personal interview campaign among all operating supervisors, from the works manager down to and including all group foremen. He is undertaking a rather Herculean task, since he is spending from 45 minutes to 2½ hours with every supervisor, and there are 750 of these in the five plants.

In each interview Mr. Allen secures the supervisor's answers to 21 questions:

1. What methods or plans have you for getting accidents under control in your section?
2. Do you hold meetings with your men? How often? And what do you discuss at these meetings?
3. How many minor accidents have your men had this year?
4. Do you investigate minor accidents?
5. How many neglected injuries have you had this year? And what are you doing to reduce neglected injuries?
6. Do your men complain at any time about the medical service? If so, what is the nature of the complaints?
7. What are you doing about unsafe practices?
8. Do you discipline men for safety violations?
9. What is the ranking of your group in the inter-plant safety trophy contest?
10. What do you think of safety prize awards, such as groceries and other prizes?
11. How many days have you gone without a major accident?
12. What are the employee representatives doing to help you in safety?
13. Have you given the employee representatives in your section a safety job to do?
14. Do you read and study the monthly accident report?
15. How do you use the monthly safety news letter?
16. Do you ever call a man into your office and discuss with him his personal safety record?
17. Do you wear safety shoes? If not, why not?
18. Are you working the safety observer plan?
19. Do you personally make a safety inspection of your section? If so, how often?
20. Just what do you think is the reason for so many accidents in this plant?
21. What can the safety department do to help you?

There is sound philosophy here. The supervisor cannot help being impressed when the safety director will spend an hour or two with him personally in a general discussion of the problem.

Then, of course, should be mentioned the fast-growing popularity of "conference method" gatherings, wherein safety directors analyze their problems and weigh experiences with small groups of supervisors in a sort of "open forum" set-up, where all speak freely and frankly on an equal basis. Such meetings are extremely helpful; in stimulating safety and in bringing out new, practical ideas.

DRAMATIZE!

Also should be mentioned the pronounced swing toward dramatization of safety gatherings. The day of the straight speech program, whether factual or inspirational—or both—is just about over. Talk there must be, of course, but nowadays speeches are sandwiched in with other varied features.

The trend toward visual education is very pronounced. The dramatization of facts and figures through charts, the use of film strips, motion pictures, etc., is very common today. The coming of motion pictures brought new possibilities for selling safety. More for the eye—less for the ear: that seems to be the new trend. The visual lesson is more easily remembered—and of course

Every accident should be fully investigated to determine the cause and, if possible, forestall a repetition

the medicine is always more pleasant to take.

Another method of dramatization is through the use of models, or actual tools or equipment. If the foremen's meeting concerns ladders and scaffolding, for example, have the carpenter shop build the models you need for effective demonstration. Jones & Laughlin Steel Company built a model of an "unsafe" ladder that attracted wide attention among employees and certainly helped focus attention on the dangers of defective ladders.

Another suggestion for keeping supervision interested is to send out monthly statements from the head office showing comparative reports of departmental operating costs to which are added the compensation and medical costs. Obviously this is mighty interesting information for the foreman.

The questionnaire method has become quite popular of late. Instead of *telling* workers what to do about safety —*ask* them what to do. That is the theory; its advantages are obvious. The employees' interest is aroused, of course, and usually he welcomes an opportunity to show supervision that he has ideas.

Some time ago a number of accidents involving "lifts" were reported to the Standard Oil Company. A general questionnaire was sent to service men all over the United States, asking their views on such accidents and how they might be controlled. Hundreds of interesting replies were received, and through careful analysis the company was able to make valuable improvements in mechanism that led to safer operation.

In like manner a leading automobile manufacturing company, having more than its share of ladder accidents, quizzed its employees to find out why. Here again many valuable suggestions were received; some were put into use. Standard Oil of Indiana likewise found the questionnaire idea effective.

This "question" method of education seems to have a wholesome effect on supervision, and foremen become interested in the interest shown by their men in answering the questions.

CHAPTER FOUR

Safety Through Competition

THE SAFETY contest idea is not new but it is tremendously popular —now more than ever before, apparently. Some safety authorities go so far as to hold that the safety contest plan is second only in importance to the stimulation that can be given by management in carrying on safety educational work.

There are three general classifications of safety contests: (1) The national competition in which special industries vie with one another for best safety records all over the country. (2) The so-called "inter-plant" contests conducted in cities among different plants, usually sponsored by local safety councils. Later the best showings made by these community councils are given special awards at the National Safety Congress. (3) The third general group consists of interdepartmental contests conducted within individual plants. Also some state contests are conducted by state safety organizations.

Safety contests are based on the fundamental consideration that complete accident records be kept. Without such records, of course, there can be no contest. There is no doubt that the contest idea is a successful and effective plan for keeping safety programs alive and keeping men interested. They may be seasonalized by turning the contest into a hypothetical football game in October, for example; a baseball game during the summer months; or possibly a horse race around Derby time.

Another recent contest trend is the general "stepping up" of prizes in contests within plants. In addition to the usual bronze plaques, medals, cups, or other standardized awards, many plants now offer cash prizes or merchandise, arranging rules so that it is possible for an individual worker or several workers to win these individual awards.

THE LOTTERY PLAN

Jones & Laughlin Steel Company has steadily "raised the ante" in plant safety competitions by offering prizes worth as much as $500 at times. The winners are determined by lottery, and, of course, only the men of that department having the best safety record for the contest period can participate. Every man eligible must have an accident-free record. The stimulation here is obvious, not only for departmental activity, but also for individual effort.

Another clever adaptation of this lottery idea is now in effect at the General Electric Philadelphia Works. Two employees are to win trips to the 25th Annual Safety Congress and Exposition, to be held in Atlantic City in October. Every employee has a chance to win. The conditions are, first, that he must have a clear accident record; second, that he show by thought and action his interest in accident prevention and the promotion of safety for the benefit of others. A "suggestion system" has been worked out in which all employees are urged to write in the "suggestion book" any thoughts they may have for the promotion of safety and the conservation of employee health. The trip will be awarded to the two employees who make the most practical suggestions, *provided* they have a clean slate on accidents.

The psychology of the contest idea is sound. Not only does it tend to keep men interested in safety, but the usual experience is that management, too, becomes aroused and takes pride in the successful efforts of employees. This, of course, reflects right back to stimulate workers and supervisors to still greater efforts.

BOOBY PRIZES

Although awards are made usually for good records, the "booby" prize plan has also become quite popular. Under this scheme bad records are held up for good-natured "razzing." Some of these plans will be discussed later.

Some firms pay a bonus representing one day's pay to each employee in every department that succeeds in working six months without a lost-time accident. Many plants permit workers who have not had a lost -time accident for a period of six months or a year to participate in a departmental or plant lottery for money or other prizes.

The Portland Cement Association has an effective contest plan in which 175 cement plant members in the United States and Canada participate. A striking concrete trophy of monumental proportions is awarded to each member plant going through an entire year without a lost-time accident. It is interesting to note that 43 of these plants finished 1935 with perfect records, and all but three of these plants had won a trophy before. On the first winning the large trophy is sent out to the city and mounted at some conspicuous point on the company property. A celebration usually goes along with the formal dedication of the trophy, with an appropriate program of speech and song. The affair becomes a community celebration and is a fine thing for the safety consciousness of all citizens, as

The white elephant is awarded by at least two plants to the department most lax in safety

well as plant employees. Where the plant wins the trophy more than once a re-dedication is made, with the facts set forth on the award. It is interesting to note that the Lehigh plant at Iola, Kansas, is now in its tenth consecutive year of no lost-time accidents.

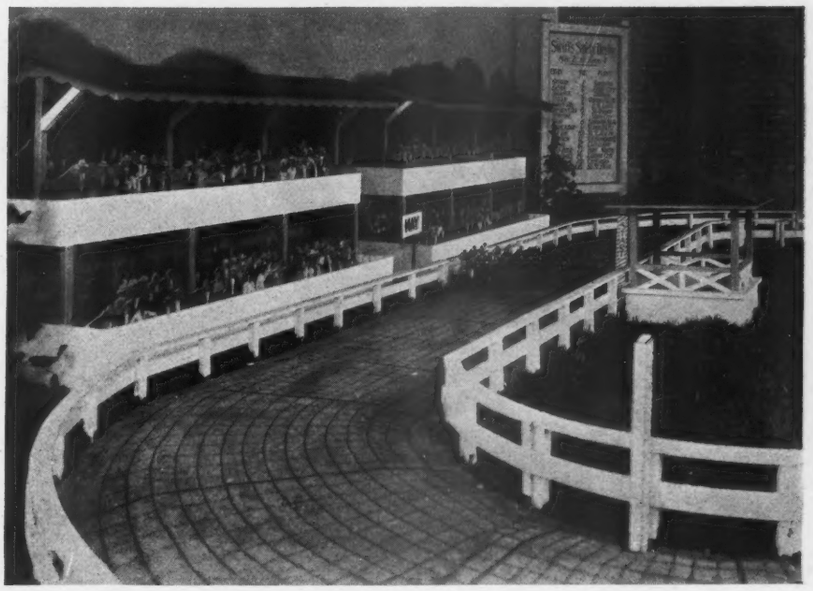
On January 1, the Portland Cement Association inaugurated its "Safety Minute Man" plan, in which all employees of all member plants in the United States and Canada were asked to sign a pledge card to drive and walk safely, and work safely. This idea, too, has had a stimulating influence.

The pledge card idea has swept the country during the past six months. Newspapers all over the United States have used the pledge idea to arouse the driving public to the seriousness of the motor vehicle accident problem. It is not a "cure-all," but it should be regarded as another of many stimulating ideas. This plan has been carried into the industry, too. "The Buick Safety Legion," for example, was organized among Buick owners who were asked to sign pledge cards to drive safely and considerately.

"Dirty Andy" is another example of the booby prize award frequently used in safety contests

Typical of the booby prize plans might be mentioned "Dirty Andy," a satirical figure, life size, fixed up by employees of the Reynolds Wire Company at Dixon, Ill. Andy is a typical dummy figure, dirty and ragged. He is awarded each month to the dirtiest department in the plant and, needless to say, is an unwelcome guest who always inspires a quick clean-up of conditions.

A cardboard replica of a jackass named "Laughing Jenny" is awarded by the management of the Bangor Hydro Electric Company to the foreman whose department has the worst accident record for the month.



Dramatizing the safety contest. Swift & Company used the horse race with marked success. Others have used baseball or other seasonal media

The Simms Oil Company, with divisions in Texas, Louisiana, Arkansas, and Oklahoma, hands over a real, live, dry-land terrapin to the division having the highest accident frequency rate for the month. "Bungle," as the terrapin is named, travels by express C.O.D., and the recipient must feed and care for it until some other division makes a worse record.

THE WHITE ELEPHANT

Similarly, the "Royal Order of the White Elephant" grew out of a razzing organization in the sales department of General Motors and was adapted to safety by the industrial relations department. The same plan was used by the Hyatt Roller Bearing Company.

The foreman of each department one day received in an envelope a picture of a white elephant without comment. A few days later a single sheet was received with the words in Old English lettering: "Royal Order of the White Elephant," and still later came a bulletin as follows:

"You are probably wondering what a white elephant has to do with safety, and in order that you may appreciate why we have adopted the white elephant as being symbolic of a bad accident experience, the following is a brief outline of a custom that exists in Siam. In Siam the white elephant is a sacred animal and can be owned only by a king. The white elephant cannot be used for income-producing purposes or for labor and furthermore, it is very expensive to keep. In Siam if someone comes under the displeasure of the king he immediately assigns to that person the upkeep of a few white elephants and on account of the tremendous expense involved in caring for them, the nobleman soon goes bankrupt. Hence, the white elephant is something to avoid if you don't have one and something to get rid of quickly if you do."

The white elephant was sent to the department with the highest severity rating. The supervisor possessing the elephant was designated as the president of the organization.

The by-laws provide that if all the members of the club have a perfect safety record for the month the safety engineer will be the honorary president for the next month and will have the honor of displaying the white elephant on his desk. If the entire plant makes a perfect safety record for three consecutive months, the elephant is presented to the works manager, who, with due pomp and ceremony, is liberally sprinkled with unholy glee and razzberries, and is then elevated to the exalted position of "Maharajah" of the "Royal Order of the White Elephant."

It is interesting to note that the Bethlehem Steel Company also uses the "white elephant" plan. It was one of many safety activities carried on last year at Bethlehem which resulted in a remarkable record. A three-cornered safety drive, involving the close cooperation of management, supervisors, and workers during 1935 netted the Bethlehem company the best safety record of its entire history. There was a reduction of 35 per cent in the accident rate from the preceding year and a reduction of 75.5 per cent from the year 1916, when the company started accident prevention work.

CHAPTER FIVE

Popular Safety Stimulators

WHEN we get into the subject of safety "stunts" we find a rich field for ideas that are both clever and helpful. Just as today's popular newspaper stunts build circulation, so do special safety stunts revitalize interest in the accident prevention program. There are any number of these that are effective, some new, others not so new. They reflect great ingenuity for the most part and therefore attract more than passing attention among those whom they are supposed to reach. They can be applied to almost any part of the broad industrial safety program.

Take the matter of bulletin boards, for example. A Maine paper mill found a unique method of keeping up bulletin board interest. There happened to be a clear view from plant gates down through the yards several hundred feet away. At the far end a bulletin board was erected, with posters set up on it. Then a large telescope was mounted near the plant gates and focused on the bulletin board. Everybody wanted a look, of course—and got it. Naturally, interest was awakened.

Walter J. Brennan, State Safety Director of Maine, tells of a bulletin board stimulator that got results. Sensing a lack of interest in the board, the director placed a little note on one corner of a poster one day, reading as follows: "Will John Smith come to my office before noon?" The note was signed by the director, of course. Now John did not show up because he had failed to read the board. He lost out on theater tickets by this failure. It only took two or three instances of this kind to get the men to reading the board each day.

GOING COLLEGIATE

Often these "stunts" are fine for morale as well as safety. A clever adaptation of a collegiate custom was used recently by the Ternstedt Manufacturing Division of Fisher Body Corporation. It is a variation of the old-time freshman "green cap" idea. The new worker in this case is the freshman, but instead of a green cap he wears a little red hat at work, not in a spirit of derision, but rather to identify him as a new man who should be helped along with friendly tips and advice for the first few days or weeks, as the case may be. Old timers as a rule are glad to help straighten out new employees when they note unsafe practices. This method makes it easier to keep an eye on them and seems to be working out splendidly. There is a nice personnel point involved here, too, for which this concern should be given full credit.

And speaking of distinctive head gear, "Bill" Fillmer, Safety Director, Youngstown Sheet & Tube Company, has apparently scored a safety bull's-eye by outfitting the crane signal men with skull caps of the bull's-eye type, the design being a red circle on the outer edge with a red dot in the center. This apparel stands out like a sore thumb in the rather dark and smoky crane bays, where, from the crane cage, it is often difficult to identify the person who is supposed to do the signaling. Arm-stretching gestures by wrong people have often been mistaken for signals and bad accidents have resulted. This clever plan solves that particular problem for Youngstown.

SAFETY POLICE

There are "safety constables," "safety watchers," and "safety police" —a popular trend that might be classed in the "stunt" category. An effective "safety police" system is in vogue at the Marquette Cement Company's plant, Cape Girardeau, Mo. These "police" are elected by popular vote. Their duties are to report all violations of safety rules to the safety committees, after which formal trials in the nature of "kangaroo courts" are held. Violators found guilty are penalized by having to do some ridiculous stunt. A "rogues' gallery" of violators is maintained. The violators are "mugged" on "arrest," and their pictures are hung up at a prominent location, along with those of other violators. M. P. Greer, Safety Director, was himself caught in the meshes of this plan when he drove into the plant one morning a little faster than the speed rule permitted. His punishment was to spend a half hour of serious meditation before the big safety trophy which adorns the plant yards, while the gang taunted him in the usual fashion.

SAFETY EXHIBITS

Unique also was the plan carried out at one of the Kimberly-Clark plants in the northern Wisconsin district recently. A miniature safety exhibit, patterned in a general way after the National Congress, was staged within the plant and proved a good interest builder. Each of six departments constructed and maintained a safety booth where all safety appliances and devices used in the department were exhibited. Each shift assigned a man to work at the exhibit so that it could be kept open 24 hours a day, since the plant is running day and night. Clever exhibit ideas were worked out. For example, in the safety shoe exhibit two hammers were kept pounding away by automatic control, one striking an ordinary shoe which, of course, was all but pulverized; the other pounding on a safety shoe which, naturally, stood up under the punishment. An interesting

An occasional exhibit of safety equipment attractively displayed, dramatized where possible, builds interest

safety contrast was thereby visualized.

This company also made cash awards some time ago amounting to $2,500, to be used by the various units in the promotion of safety contests to spur interest and make competition really worth while.

A National Safety Council member recently organized a monthly "hazard hunt." Each safety committee member was asked to "chip in" to a common jack pot. Then the men were all set loose in the plant for an hour to hunt for accident hazards. The one who found the greatest number of serious hazards won the pot. The chairman of the committee served as judge of the contest.

Hammermill Paper Company employed two characters, one labeled "Safety Bill," carefully dressed as a safety committeeman, and one labeled "Careless Eddie," dressed and painted like a clown. They were sent through the plant together. "Careless Eddie" got into all the trouble he could find. Then "Safety Bill" would save him, caution him regarding unsafe practices, usually with a crowd around to listen. This temporary stunt created considerable interest.

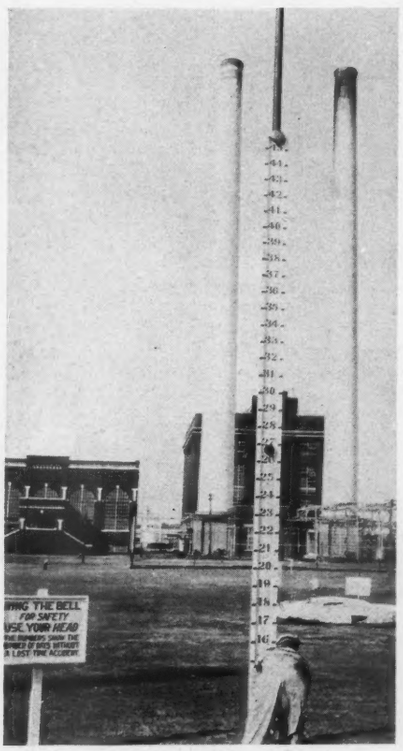
SPILLING THE BEANS

Unique was the plan of the Hayes Body Corporation, Grand Rapids, Mich. A bulletin board was designed to hold 170 little bags of beans with the name of a worker and his badge number on each bag. Above was the legend, "Don't spill the beans." If an employee had an accident, the bean bag that carried his number was cut open and the beans were spilled. Two other items were displayed on the board; to the left the pay checks cut in two, and to the right an accumulation of bills, both of which accompany lost-time accidents.

The American Hard Rubber Company draws the name of one employee each day from a "contest barrel." On the following day, if all the employees work without accidents, this one draws a prize. The wording on the bottom of the board reads: "Would you like to win a cigar or a pack of cigarettes or candy? Here are the simple rules: Every day at noon the name of an employee will be drawn and the name placed on the board for the next day. For every day the factory operates without a lost-time accident the person whose name is posted has his choice of the prizes offered. Work safely every day. Somebody will win; maybe you. Who knows?"

The members of the safety committee in a certain department provided themselves with new brooms and suitable signs that read: "We are going to sweep the slate clean," and then marched two by two through the aisles of the plant.

A worker got a foreign particle in his eye for his failure to wear goggles. He agreed in a special safety campaign to go up to each man in his department and say: "Don't do as I did," while wearing a blind over his eye and with a pair of goggles in his hand.



An example of a safety stunt sure to attract interest and make the workers think about safety

A foreman installed a locomotive bell in a small department in a large midwestern plant. He rang this bell for a few minutes at different times each day. It was simply an official reminder to the men to work safely.

The Mid-Continent Petroleum Corporation borrowed a county fair stunt —the old muscle-testing, bell-ringing idea. A dummy figure was placed in the position of striking the machine. On the upright were painted the graduated figures. A round weight held in place by a wire indicated the number of days passed without a lost-time accident. The sign at the left said: "Ring the Bell for Safety. Use Your Head."

During November and December, Union Carbide & Carbon Corporation conducted a turkey raffle which was publicized as "The Gobbler's Chance." On the first day of November all names on the hourly payroll were put in the box. At noon each day two names were drawn from the box and put on the bulletin board. These names were also placed in a smaller cigar box where they stayed, provided there were no disabling injuries in the plant on that day. At the end of the week there were 14 names in the cigar box. This was continued until the day before Thanksgiving, when the four boxes (one for each week) were brought out and a name drawn from each box by the superintendent. Each of the four men was presented with a live turkey.

In a certain machine shop a poster was displayed on the bulletin board reading as follows: "There is a safety slacker here. Too tired to wear goggles. Good-bye, 730 no-accident days." An hour later three men reported to the stockroom for goggles; one apologetically, one shamefacedly, and the third indignantly.

A barrel and sign reading: "Drop your unsafe habits here" were placed at the entrance gate of a plant for several days during a safety campaign.

"Old Man Carelessness" was laid to rest at the Chicago plant of Joseph T. Ryerson & Sons, Inc., in a special "funeral," one of the features in a special no-accident campaign. The burial was preceded by a parade of all employees, headed by a ten-piece band mustered from among the workers.

The race track scheme, already mentioned, is extremely popular. Miniature race tracks were installed in the yards of each of 17 plants of Swift & Company. Seventeen "ponies," each representing a plant, entered the 30-day contest. Each pony was advanced one space for an accident-free day.

The Bigelow-Sanford Carpet Company used an airplane to distribute 5,000 safety circulars as a climax to its plant safety contest.

A safety thermometer was used successfully by the American Sugar Refining Company. Large sign boards are extremely popular in advertising special contests. One plant built a miniature cottage, with all the appurtenances, standing in the midst of the grounds, brightly lighted, until the day should come when it would be darkened and crepe tied to the door, the sign that a disabling injury had occurred.

PRIZE-WINNING BALLOONS

A thousand gaily colored balloons, each carrying a small card containing a brief safety message, were released by the Duluth plant of the Universal Atlas Cement Company, subsidiary of the United States Steel Corporation, in a special safety celebration. The persons finding the balloons that traveled farthest from Duluth received individual prizes of $25, $10, $5, and $1.

The Newport Rolling Mill Company erected a ladder on the side of the main building. A dummy was started at the base of the ladder on the first day and was advanced one step for each accident-free day.

Rotating safety exhibits in larger plants have become quite popular during recent years. They are arranged in attractive display form and are sent on a tour of plant departments or units.

Western Electric, Hawthorne Plant, Chicago, used a portable safety clothing exhibit in this way and found it a successful interest builder some time

ago. A framework built in pyramid shape was covered with green billiard cloth on which the various items were shown to advantage. The pyramid, about 5 ft. high, was mounted on a truck. On four sides were displayed respiratory equipment, goggles, safety hats, copper-clad leather puttees, safety shoes and wooden soled platers' shoes, hair nets, and safety gloves of all types, from heavy welders' gloves to finely woven cotton ones used by women employees in performing delicate working operations. Western Electric has used several of these exhibits in the past, one being a combination "Safety and Health Exposition," which attracted wide attention.

A more recent dramatization for exhibition purposes at Hawthorne was a life-sized photo, cut out and mounted to stand, showing a worker who had just dropped a 70-lb. die on his foot. The accident really occurred, and the worker escaped injury because he was wearing safety shoes. On a pedestal at the side of the cut-out was the actual shoe with only a slight dent across the toe where the corner of the die had struck it. The photograph, of course, pictured the man himself and showed the actual die that had hit his foot.

At Westinghouse Electric excellent results were secured by fitting up an electric truck with a number of the more commonly used items so often involved in plant accidents. This truck made a journey throughout the entire plant, being stationed for a day or two at a time in certain departments that had the worst accident records. During the noon hour the exhibit was stationed at the exit.

Displays of mushroomed tools, goggles that actually saved eyes (and there are hundreds of these cases every year), defective hammers, defective electrical equipment—in fact, any of the well-known mechanical accident producers can be used effectively in this way. Many plants now have permanent safety exhibits.

A "safety train" consisting of a motor truck and trailer built to resemble a locomotive and coach has visited hundreds of schools in Indiana and safety talks have been delivered to more than a quarter million school children. This illustrates the present-day trend of many industries that carry on safety work beyond their plant gates, into the homes of their employees, to the public generally, and out on the highways. This plan was sponsored by the Lincoln Oil Refining Company in Indianapolis, and in connection with this program it organized school patrols in 31 towns.

CHAPTER SIX

Plant Inspections

THE IMPORTANCE of good housekeeping and of frequent inspection leading to the discovery and correction of hazards, is emphasized now more than ever before. Almost invariably in plants with good records you will find a very thorough and complete inspection program carried on all the time. You will find very strict rules against sloppy housekeeping, and these rules are enforced to the letter.

Some plants hold regular monthly inspections reaching every corner of the company property; others insist on thorough inspections at least once a week. International Harvester Company has a system of daily inspection that is quite out of the ordinary. A set of cards bearing the names of the respective departments is shuffled each morning, and the man in charge of the reception room telephones to each department head daily that he is to make the 15-minute safety inspection of his department after the next quarter hour.

Thus the foreman makes his regular inspection at a different time each day and reports his findings on a special form once a week. It has been found that this has been very valuable in keeping safety in the foreground where the rush of production might divert the interest of the foreman, even though he might have the best of intentions.

From experience it has been found that it is better to change the time of making the daily inspection each day than to have it at a given time when men are likely to be on their good behavior and perhaps are not acting naturally. The monthly inspection of the plant safety committee is a check on the efficiency of the foreman's daily inspections. The net result has been a much higher standard of housekeeping and more faithful use of machine guards and protective equipment.

ATTENTION TO HAZARDS

The Youngstown Sheet & Tube Company, Western Division, uses an interesting scheme to focus attention on hazards. It is a daily report, required of all foremen, on unsafe practices corrected. If the foreman has not corrected any unsafe practices during the day he writes "None" across his report, signs it, and sends it in just the same. After the department head has noted each report it is then sent to the safety department where a record is kept of the number of unsafe practices every foreman reports as having been corrected. The foremen know, of course, that these records are available in studying the accident experience of their department. Many items from these reports are reproduced in the weekly plant bulletin issued by the safety department and this informs other foremen how some are stopping these hazardous practices.

The "police" idea helps out in general safety inspection work. Two companies—Youngstown Sheet & Tube and Standard Oil of Indiana—simultaneously but independently developed a plan whereby each foreman or supervisor was encouraged to appoint one or two of his men to serve as safety "observers" or as safety "sponsors." These workers continued their regular jobs, but in addition they were given partial responsibility for the safety of all the men in the gang for a period of one month or six weeks. They advised the other men and the foreman about unsafe conditions and unsafe practices and if the gang went through the period without any disabling injuries they were given a considerable portion of the credit for the accomplishment. At the end of the period each foreman appointed one or two new observers to try to beat the records of their predecessors. In one plant employing 1,000 men this stunt had the effect of adding 100 safety men at no extra cost.

The rotating safety committee idea has also been carried on effectively at Western Clock Company, La Salle, Ill. This plant, which holds the all-time safety record among National Safety Council members, having amassed more than eleven million safe man-hours, has a central safety committee of six, mostly old-time foremen. They meet with the superintendent of the plant every month and have their own meetings frequently. To maintain a direct contact with employees, two members of each of about 50 departments work with them as a workers' committee, and these appointments rotate. The workers' committee invites suggestions and is continually on the lookout for hazards which, if found, are corrected as soon as possible.

Housekeeping campaigns are popular. For some time each of the six plants of the Murray Corporation of America was engaged in a permanent clean-up drive. Inspections were made every month by special committees in each plant who checked housekeeping conditions according to a schedule that allowed a possible ten points for each of the ten items. The items included:

1. Aisles—clean as possible.
2. Stocks—safe piling, angle, height, location.
3. Refuse—food, paper, bottles, use of receptacles, floor loads.
4. Personal hygiene—clothing, cleanliness.
5. Sanitation—toilets, washrooms.
6. General appearance—notices.
7. Industrial hygiene—expectorating.
8. Waste—air, gas, water, light.

9. Property damage — equipment, building, record of broken windows.

10. General carelessness — running, horse play, etc.

Each month the department rated cleanest on the basis of this schedule was awarded the safe housekeeping flag and a substantial cash prize was also given to the department winning the flag two months in succession.

The Carnegie-Illinois Steel Corporation has a "Safety Leader" system, a safety leader being appointed for every six men and having supervision over their safety. He makes a daily report concerning near accidents or dangerous practices. He also makes recommendations with reference to the guarding of machinery or anything else that may improve conditions. From November 1, 1925, to January 1, 1934, at the Homestead Works of Carnegie Steel 2,990,504 reports were made, of which 21,614 were definite safety recommendations. More than 18,000 of these were approved.

CHAPTER SEVEN

Safety "After the Whistle Blows"

ONE of the most interesting of new trends in industrial safety is the attention now being given by industry to traffic accidents occurring to employees outside the plant and outside of working hours. Five times as many occupational workers die annually in traffic accidents in no way connected with their employment as are killed in similar accidents that occur during working hours.

The problem of safety "after the whistle blows" is therefore a pretty serious one. One member of the National Safety Council, with a working force of several thousand persons, made a recent study covering a period of eight consecutive years. The ratio of outside to inside injuries increased from 2-1 in the first year to 6-1 in the eighth.

STARTLING FIGURES

Another large member establishment reported that 21 motor vehicle fatalities involving its employees occurred during a single nine-month period. About 3,000 industrial employees are killed each year in motor vehicle accidents that arise out of or in the course of their work. But only recently it has become known that an additional 15,000 of these workers are being killed each year in motor vehicle accidents that are in no way connected with employment. In short, no less than 18,000 persons in the occupational group are included in the total annual human waste accounted for on our streets and highways.

Now these are startling figures. Although no compensation payments are involved in injuries not connected with employment, the cost of hiring and training new workers is alone a serious item of expense. Each worker represents a definite investment. Often his experience and skill may be difficult to replace. Definite plans to cooperate actively in the war on traffic accidents are already being carried out in many plants throughout the country. In seeking the active cooperation of industry the Council makes several specific suggestions to plant executives, looking toward the improvement of this bad situation. Some of these follow:

1. The organization of a "Safe Drivers' Club" or "League" within the plant, the object of which will be to cooperate with local authorities in their effort to promote and aid in the conservation of individual, industrial, and community life; to conduct a continuous educational safety campaign; to teach the doctrine of individual responsibility for the safety of themselves and their families, their fellow employees, and the community in general; and to promote good fellowship.

2. Personal letters to employees from management at frequent intervals.

3. Safety pledges by employees.

4. Free inspection of employee automobiles established by the plant, including such important factors as brakes, tires, wheel alignment, steering mechanism, lights, and efficiency of windshield wiper and rear-view mirror.

5. Providing parking facilities near the working place.

6. Providing free vision tests and physical examinations.

7. Providing for the distribution of safety literature.

8. Publicizing the traffic accident problem on the plant bulletin board.

9. Timely motor vehicle accident articles in employee magazines.

Visiting, horseplay, and practical jokes must be strictly prohibited. If they are not, safety is bound to suffer

10. Safety campaigns for both drivers and pedestrians entering and leaving company property.
11. First-aid training and contests.
12. Contests for employees' children.
13. Full cooperation with local authorities.

The plea for cooperation is based on the belief that even though an employee is not directly under the supervision of his employer, when the working day is over he more than likely will respond to the leadership of his employer in a drive for traffic and highway safety at all times.

Commenting on this campaign and the importance of enlisting industry. E. C. Schultes, Jr., Safety Director of C. Hager & Sons Hinge Manufacturing Company, recently said: "Industrial folk cannot emphasize too strongly the need for safety outside the plant. We of the Hager Hinge company have had this fact brought home to us most forcibly within the last month.

"On Saturday evening, March 15, seven of our employees, all young men, left St. Louis for a trip into the country. On their return trip, the machine was ditched with the following results: The driver was killed, four of the group received possible skull fractures, broken limbs, cuts, lacerations, and possible internal injuries which put them in the hospital. The remaining two were bruised and cut and considerably shaken up, but went home after receiving emergency treatment.

"These men were all employees of a plant that enjoys an enviable and outstanding record in the St. Louis district. Our safety organization was functioning 100 per cent, and we were practically free of any type of accident. It shall be our job henceforth to stress more than ever the hazards that employees might encounter away from work."

CHAPTER EIGHT

Measuring Results

THE QUESTION naturally arises, are these safety stimulators, supplementing standardized safety programs, really getting results? What is the general industrial accident trend?

We know that accidents arising out of gainful employment increased somewhat from 1934 to 1935, but so far as National Safety Council members are concerned the increase was less than the increase in employment, with the result that accident rates on an exposure basis really decreased between the two years—which, of course, is a hopeful sign.

The fatal accident total in all occupations for 1935 is estimated at 16,500; permanently disabling injuries are believed to total 63,000; and there were approximately 1,340,000 temporarily disabling injuries in work accidents.

The death toll was 500 higher than in 1934, but is still much lower than in any of the pre-depression years. While accurate figures cannot be arrived at prior to 1928, various authorities have estimated annual occupational deaths at 20,000 to 25,000 during the early 1920's and from 25,000 to 35,000 during the previous decade. Now assuming that the occupational death total was about 35,000 in 1913, with gradual reductions down to present levels, it is fair to say that about 250,000 fewer persons have been killed in work accidents than would have been fatally injured had the national totals continued at the 1913 level.

Contrary to the impressions of many, most fatal work accidents do not occur in factories or in mines, nor in any of the other occupations that are popularly thought to be hazardous. Rough approximations result in classifying the largest number of 1935 occupational fatalities among persons in agricultural pursuits. There were an estimated 4,400 deaths in this classification compared with 4,000 in the trade and service industries, 2,500 in construction, 2,100 in transportation and public utilities, 1,900 in manufacturing, 1,600 in mining and similar operations.

As already stated, companies reporting detailed records—approximately 4,000 firms—were able to reduce their accident frequency rate (disabling injuries per one million man-hours of exposure) 10 per cent from 1934 to 1935. And they also accomplished an 11 per cent decrease in the injury severity rate (days charged per 1,000 man-hours of exposure). These downward movements in rates are in pleasing contrast to the increases of 5 per cent that occurred in both rates from 1933 to 1934.

The 1935 reports as shown by industries tell an interesting story. The tobacco industry, laundries, and the cement industry rank one, two, three in best frequency rates among 30 sectional groups. In severity "lows," cement, laundry, and printing and publishing have best records.

Dial feed on a press makes it unnecessary for an operator ever to have his hand in the danger zone

CHAPTER NINE

Common Causes of Accidents

REPORTS from industries of all types in a group of industrial states for a recent year show injuries resulting from 11 distinct causes and the greatest of these was the handling of objects—that sometimes simple, sometimes difficult, but always necessary industrial operation. This group accounted for 25.9 per cent of all the accidents.

The other leading industrial accident causes and the percentage of the total they represented were:

Falls to a different level, 8.7 per cent.
Falls to the same level, 9.5 per cent.
Machinery, 12 per cent.
Vehicles, 10.9 per cent.
Using hand tools, 7.6 per cent.
Hauling objects, 8.7 per cent.
Stepping on or striking against objects, 5.6 per cent.
Electricity, explosives, heat, 3.6 per cent.
Harmful substances, 2.1 per cent.
Miscellaneous causes, 5.4 per cent.

The high frequency of accidents caused by the handling of objects is not strange in view of the fact that a large part of all industrial operations consists of handling material—piling, unpiling, loading, unloading, carrying, lifting, and transferring by hand and by power. Handling material, according to reports, is the safety man's greatest problem. It quickly falls into several major groups: By hand, by hand truck, by power truck, by other mechanical equipment (overhead cranes, elevators, derricks, electromagnets, railroad cars, etc.).

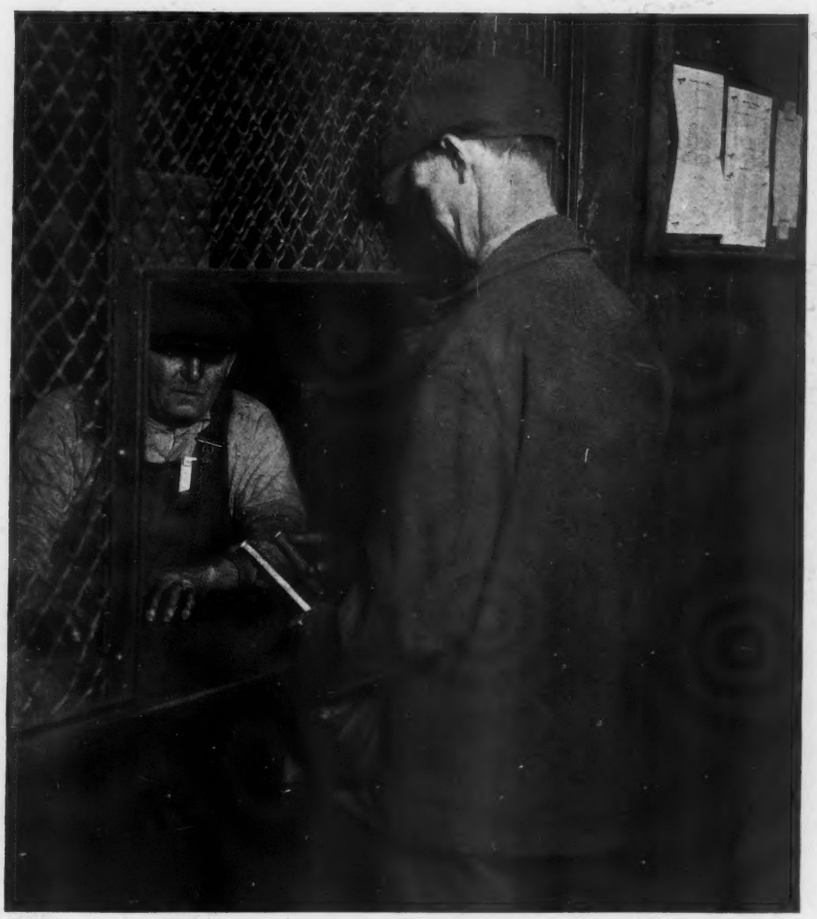
Handling material by hand, where the hand and body constitute the principal equipment used, is obviously and almost exclusively a human operation. Employees should know how to carry material, how to lift it safely to avoid rupture and strains. They should be instructed in safe ways to pile or load material on a warehouse floor, a shipping room platform, or in a lumber yard to avoid hastily done, unsafe, and poorly balanced jobs that will quiver and come cascading down on top of employees when subjected to vibration or an unintentional push.

By hand truck. Here again careful loading and unloading will avoid pinched fingers, the shifting or falling off of the load or breakage of the truck from overload and the attendant hazard of injury to operator or bystander. The placement of wheels to distribute the load evenly to prevent tipping makes a hand truck safer. Wide, clear aisles, with their edges or "curbs" painted on the floor, should be the route of a hand or power truck used in transporting material from one part of the plant to another.

Truck handles should be of the proper length and equipped with shields to guard against scraping or crushing the operator's hands. If for no other reason than that hand trucks seldom are equipped with brakes, a selective choice should be made to provide the type least apt to get out of control and "run wild" through the plant with a heavy load.

Power trucks involve some mechanical hazards, but their principal threat to safety is similar to that of the hand truck. However, other mechanical equipment used in handling material often carries the threat of fly wheels and connecting rods of engines, pinions and gears on booms, installation of ladders or steps, hand rails, cable breakage, and the operating hazards of mechanical lifting machines. All moving parts of engine mechanisms should be covered or guarded in such a way as to make it impossible for clothing, fingers, or arms to become caught.

All ladders, steps, hand-holds, and other means of access to the mechanical material handler should be so located that they cannot be damaged by passing wagons, trucks, or railroad cars, making them unsafe for the worker who must use them.



Frequent, careful inspection of all tools will keep many a lost-time accident from ever happening

FALLING LOADS

In operations where cranes, overhead conveyors, derricks, car-loaders, and the like are used, there is always the danger of falling loads, cable breakage, and the too-often-consequent injury to employees standing under the load or near the machine. It is always hazardous to carry material over the heads of workmen.

Where cranes are used the practice of hooking the load as the hoisting cable is pulling the load upwards and before the sling is tight should be prohibited.

The slope of aerial runways and chute conveyors where packages are moved by gravity should be so adjusted as to allow materials to flow steadily, but should not be so steep that packages will emerge at high speed with the possibility of causing personal injury and property damage.

Proper lighting of work areas is a basic safety weapon

Blowers should be so designed that a person cannot be drawn into them. The hopper should extend at least arm's length from the blower or duct and sharp edges on flexible pipes used to pick up light material such as cotton, lint, and grain should be smoothed.

Car loading and tiering machines, to be safe, must be of a type that will not easily tip over, and because of their portable nature should have electric wiring incased and armored cable that is grounded. Car loaders should be of a type that does not require employees to be at the end of the loader where the material is discharged.

The loading or unloading of any type of railroad car has its special problems. In unloading and loading miscellaneous freight from box cars adequate light should be provided and runways from the cars to platforms should be firm, strong, and laid flat to make trucking of the load easy and safe.

Many employees are injured by having feet and hands pinched between pieces of freight and between freight and the car or truck. The material most hazardous to handle on and off flat cars is heavy, round material in long lengths—pipes or logs. Stake pockets of a design that quickly releases the stakes are a big asset in reducing accidents, as the car unloading crew can stand away from the place where the load will fall.

The second most important cause of injury in occupational pursuits was falls, amounting to 18.2 per cent of all injuries. Of these, falls to a different level accounted for 8.7 per cent; falls to the same level, 9.5 per cent. Incidentally, falls constitute the outstanding cause of death and injury in our homes.

Types of falls suffered by industrial workers include falls on stairs or steps, primarily due to unsafe conditions, such as slippery, worn, broken, wet, or icy treads; lack of guard railing; inadequate landings. Contributing causes may be loss of balance by the worker, inattention, carrying too heavy a load, tripping over loose objects, inadequate lighting. Correctly built stairs of even riser height, at a safe angle, with treads constructed of or covered with anti-slip material and maintained free of defects, will reduce the stairway falls, provided the stairs are well lighted and kept free of obstructions.

LADDER ACCIDENTS

Falls from ladders are due mainly to the breaking of the ladder; its slipping or twisting; to the victim getting knocked off the ladder; slipping of the ladder feet or loss of balance; falling while getting on or off the ladder or while working on it. All ladders should be constructed of substantial material, maintained in safe condition. They should have frequent and thorough inspection and should be of the type suitable for the purpose used. Portable ladders should have safety feet and, where possible, safety hooks at the top. They should not be placed at an angle of less than 75 degrees with the horizontal or they may fall, break, or slip.

Workers should check ladders carefully before using, regardless of inspection practices. They should always face the ladder when ascending or descending, and tools should be carried in suitable pockets or hoisted in a bucket to leave both arms free for climbing or for emergency. Where hand tools are used by a workman on a ladder there should be a safety platform.

Frequent too, are falls from scaffolds, stagings, runways, balconies, platforms, and gangplanks, due to breakage, tilting of apparatus, and defective or broken surfaces; falls while handling objects; slipping or loss of balance; and tripping or stumbling over loose objects. Breakage is usually caused by defective material, lack of adequate supports, or placing of too great weight on the structure. First class material, good workmanship, and frequent inspection to insure proper maintenance are essentials to safety. Suitable and properly maintained hand rails should be provided. Flooring should be laid to avoid overlapping at unsupported points and should be kept free from defects, icy or slippery surfaces. Toe-boards should be provided wherever possible.

A great many falls occur from benches, boxes, tables, and chairs used as substitutes for ladders. The remedy is obvious.

Falls from buildings often occur in collapse of walls, floors, or supports; failure to use proper ladders, scaffolds or staging, or by not having proper safeguards at wall and floor openings. Roof falls may be prevented by suitable guard rails at roof levels, by catch platforms slightly below and away from the eaves, by the wearing of safety belts and life lines, and by use of other working equipment. Window washers are frequent victims, in most cases because they fail to make proper use of their safety equipment.

There are fatal falls from towers,

too, and from tanks, elevated bins, and pockets. Linemen are frequent victims, due quite often to failure to use —or to the improper use of—standard safety equipment; or because of failure to inspect equipment or poles.

Suitable scaffolds and staging will prevent many falls while erecting, inspecting, or repairing boilers, engines, and machinery. These structures should be kept free of loose objects and of oily and greasy surfaces which may cause slips. Permanent balconies or platforms with hand rails and toeboards and with stairs for ready access are used in some plants to make machinery inspection and oiling easy and safe.

Crane accidents have been reduced through installation of guarded railings, ladders, and stairways. In many plants suitable railed walkways are provided along the entire length of the overhead crane runways. No one should be allowed to ride on crane loads or on hooks or blocks, etc. Standardization of crane signal systems has done much to reduce crane accidents.

ELEVATOR ACCIDENTS

There are many falls into floor openings, due partly to lack of suitable inclosures about the openings and partly to inattention. Elevator accidents have been reduced by use of interlocks on gates and also by enforcement of strict rules regarding use and operation, covering both the operator and the passenger. Excavations, ditches, and pits also take their share of victims, due mainly to lack of proper guarding.

Falls on level surfaces are due to slipping of the foot, defective surfaces, slipping or breaking of tools, foot catching, and to the handling of objects. Good housekeeping is the main remedy here—with plenty of educational work. Where material is kept in suitable storage and refuse is properly disposed of, much will be done to eliminate these accidents. Aisles and passageways must be kept clear, unobstructed, and well lighted—and should be marked. All piling must be made safe and kept out of the way. Tools not in use should be stored, and waste and oily material kept in metal containers. Look out for grease and oil drips, and sprinkle sand temporarily to absorb what cannot be taken up with rags or waste. Floors should be kept in good repair, free from any unevenness or rough or slippery conditions which may cause a person to trip, slip, or fall.

The third group in numerical importance is machinery accidents, representing approximately 12 per cent of all the injuries. The leading causes in this classification are lack of or failure to use machine guards; the breakage of machinery because of defects or improper handling; failure to wear goggles or safety shoes or other protective equipment; getting clothing caught in moving machinery. Belt accidents due to lack of guarding or hand shifting; oiling machinery while in motion; failure to lock the switch box on machinery that has been stopped temporarily, resulting in someone getting hurt in a sudden start-up; failure of women to wear the right kind of clothing or to keep their hair protected by nets; the bad habit of visiting while working around moving machinery; horse play; startling machine operators by yelling at them or poking them; the failure to wear goggles in chipping, grinding, and other machine work hazardous to the eyes.

MACHINE GUARDS

Mechanical safeguarding has reached a high state of efficiency. Satisfactory guards are now available for just about all machine operations where there is any danger to the operator. These include guards for power presses, for exposed gears, fly wheels, emery wheels or other grinding wheels; guards for lathes, milling cutters, power saws, screw machines, drills, planers, etc.—in fact, for almost every piece of machinery where normal operation is at all dangerous.

Progressive plants today have their machinery well guarded and insist that workers keep these guards in repair and in use. This policy is fundamental in today's safety program, and as a result this type of accident has been reduced greatly. More and more, as already hinted, machine guards are being built in by the manufacturers, which, of course, lessens the chance for their removal. Workers used to remove guards for oiling or repair work and then simply forgot to replace them.

Breakage of machinery is much less common than formerly, because of frequent, thorough inspection, careful lubrication, operation at proper speeds, and limiting of the type and size of work to what the machine was built to do. The human factor plays a big part in machine accidents, of course, and here constant alertness is essential.

Vehicles caused approximately 11 per cent of the industrial accidents. About 80 per cent of these involve commercial automobiles; the remainder include mine and quarry steam or electric cars; contractors' cars and engines; animal-drawn vehicles and plant trucks, cars and motors on tracks.

The experience of hundreds of commercial fleets—trucking, delivery, taxicab, bus—shows that these accidents can be reduced and to a remarkable extent controlled. A commercially operated passenger car fleet has established the enviable record of 1,784,028 no-accident miles; a truck fleet has achieved a perfect record of 966,000 miles; and a bus fleet has gone 1,229,-143 miles without a mishap.

SAFETY MEDALS

More than 30,000 medals have been given to commercial drivers in various fleets throughout the country by the National Safety Council during the past five years. These include one-, two-, three-, four-, and five-year awards.

From 1934 to 1935 the registration of passenger automobiles increased slightly less than five per cent, whereas truck registration increased six per cent. This difference is insufficient, however, to compensate for an increase of five per cent in the number of trucks involved in fatal accidents compared with an increase of only two per cent in passenger cars so involved.

This is now the third year in which

Handling of dangerous chemicals is safe in this outfit

trucks involved in fatal accidents have increased, following the low point of 1932. However, they still hold a decided advantage over passenger cars, if comparisons are made with 1927. From that year until 1935, passenger cars involved in fatal accidents increased 58 per cent, whereas trucks so involved advanced only 15 per cent.

Buses, taxicabs, and motorcycles have relatively small registrations and consequently year-to-year changes in accidents are not such reliable indications of trend. Over the period of years from 1927 to 1935, however, buses now show a decline of 20 per cent and taxicabs a reduction of 49 per cent.

Companies making the best fleet safety records follow a program that has been pretty well standardized. First there is a wholesome interest by top management. Second, strong disciplinary control over the drivers, holding them responsible for accidents and rewarding them for accident-free records. Drivers are selected with extreme care; medical examinations are given, of course. Investigation of the experience and record of the applicant through inquiries to previous employers; "trials," during which time the new man works under the guidance of an experienced safe driver; training schools for new men; oral and written examinations with demonstrations of driving skill—these are all essential preliminaries. But after that there is continual safety stimulation and also constant supervision. Thorough and frequent vehicular inspection, of course, plays a part in commercial fleet accident reductions.

HAND TOOLS, TOO

Even in this age of machinery many industrial operations are performed largely, if not wholly, by the use of hand tools and these caused 7.6 per cent of the industrial accidents.

The danger of cutting edges—of chisels, axes, draw-knives, planes, shears, shovels, saws—is obvious, as is that of the pounding surfaces of hammers, sledges, or tamps. They cause accidental lacerations and smashed hands, feet, and fingers. Hammers, axes, and the like should not be used by two or more persons working close to each other. Dented skulls attest the danger of flying axe or hammer heads.

It is of prime importance that hand tools be made of the best material so that sharp edges will not splinter, and so heads of punches, chisels, and hammers will not mushroom or crack. Hammer, axe, shovel, and wrench handles should be securely fastened to their heads and be made of first-grade, straight-grained wood that is strong enough to meet the greatest strain to which they will be put.

Many industries equip their employees with leather or other sheathes in which to carry sharp or pointed tools when they are not being used. Tools used by unskilled workmen, particularly, should be turned in at the end of the day, inspected by the foremen or crib man and necessary repairs made before they are re-issued for use. Under no conditions should tools be left lying around for employees to fall against, stumble over, or run into.

Wrenches, of improper size for the nut to be tightened or loosened, and with worn or uneven jaws that slip under pressure, cause many injuries daily. The right tool, well made, in excellent repair, used carefully, and then stored where it will hurt no one, is a safe instrument.

FALLING OBJECTS

Sixth in numerical importance come falling-object accidents, accounting for 8.7 of the injuries in all industries. Common causes in this group include improper piling or storage of material; leaving tools or other objects on shelves or benches where they can be knocked off or where they fall because of machinery vibration. Piling racks are used effectively in many plants today, and reinforcing with cross-piling helps prevent the spilling of material. Where strict instructions are given and carried out there are very few falling-object accidents.

Next on the list are accidents due to stepping on or striking against objects, accounting for 5.6 per cent of all the accidents.

Electricity, explosions, and heat accidents caused 3.6 per cent; harmful substances, 2.1; while other miscellaneous causes took up the remaining 5.4 per cent.

It might be interesting to note that injuries to hands and fingers account for 33 per cent of all the industrial cases; that leg and foot injuries occur in 24 per cent of the cases; trunk injuries in 9 per cent of the cases; arm injuries in 11 per cent; head injuries (other than eyes) in 6 per cent of the cases, and eye injuries in 2 per cent.

INFECTIONS

There were more than 100,000 occupational accident infection cases last year where disability lasted for at least one week. It has been estimated that about 72 per cent of the infection cases are hands and fingers; legs and feet, about 17 per cent; arms, about 7 per cent. Infection cases have been reduced pretty generally throughout industry during recent years. Most plants now make it compulsory for workers to receive first aid promptly for even the slightest injuries. Efficient medical departments, which all larger plants now have, provide not only first aid but a most careful "follow up" on all cases.

Competition is so keen, and sales prices are so nearly equal, that controlling production costs is a major problem of industry. Accident costs must, of course, be included in production costs, and if neglected may cause sales to drop off or profits to shrink.

Accidents can be controlled if company executives will take the time and trouble to see that plant conditions and equipment are safe, that foremen teach their men to do their work in the safest and most efficient manner, that workers are supervised—and disciplined, cajoled, enticed, if necessary—to make sure they follow the procedure developed by those in authority.

Not only is it possible to cut production costs by effective safety work, but safety offers a stepping-stone to better understanding between employer and employee. Safety programs bring employers and workers closer together, make it easier to work out solutions for other matters of more controversial nature.

Models are used to good advantage in safety discussions

PLANT LIGHTING

EIGHTEENTH IN THE SERIES OF

FACTORY MANAGEMENT and MAINTENANCE

PLANT OPERATION LIBRARY

CHAPTER ONE

Workers Need Lots of Light

INDUSTRY spends huge sums in time studies every year to determine the cost of individual operations, and ways and means of promoting efficiency. Insurance companies, the National Safety Council, and other organizations work ceaselessly to determine the causes of accidents and find methods of preventing injury to workmen. Dangerous machines are equipped with safety guards. Automatic devices have been perfected to guard careless employees. Shields and goggles of many types have been devised for eye protection.

With all this activity, artificial light—which is the least expensive tool for combating these problems of industry—is frequently neglected.

Experience of various industries shows that inadequate and glaring illumination is the direct cause of at least 15 per cent of industrial accidents. Industrial fatalities alone amount to more than 1,500 a year. The cost of all accidents in industry is more than $150,000,000—enough to pay for a lot of lights.

From the humanitarian viewpoint, money cannot buy a human life nor adequately compensate for the loss of eyesight or limb. If only for this reason alone, management is obligated to provide good lighting in factories.

For instance, a manufacturer employing 1,000 men and women averaged 425 accidents annually, which cost $15,000 in compensation. The annual cost of power to operate the very poor lighting system was $1,900. Efforts to reduce the cost of accident compensation led to the installation of a new system.

It increased annual power cost to $7,300, but in the following year accidents were reduced from 425 to 170, and compensation cost was $6,000 instead of $15,000. Better lighting had saved $1,700 in one year.

Employees can work only as fast as they can see; when the lighting is poor the eyes take longer to record the visual impressions. This phenomenon is strikingly demonstrated in the action of the camera. To get a clear, unblurred image of a moving object, the light must be strong.

BETTER LIGHT, MORE PRODUCTION

That is why tests indicate that increases in production ranging from 12 to 25 per cent may be expected when good industrial lighting is substituted for poor lighting, at a cost of from 2 to 3 per cent of normal payroll.

Possible production increases and reduced costs depend primarily upon the initial lighting conditions of a factory,

Where it is desirable to obtain a high level of illumination over a long row of work benches or inspection tables that cannot effectively be lighted to proper intensity from a general lighting installation, the larger of the bowl reflectors can be installed on close spacing at low mounting height, a method that will provide from 30 to 60 foot-candles on the working plane

the increase in the intensity of illumination, and the extent to which operation depends on quick, accurate vision.

Low-cost production depends largely on minimum spoilage which, in turn, is dependent on the workers' ability to see. Tired or defective eyes are not conducive to accurate work.

Except for a few outstanding examples of extraordinary lighting, industry is getting along with somewhat primitive standards. According to a survey in several thousand industrial plants in 85 cities, the general level of illumination was less than 3 foot-candles, which is a good indication of the situation in 170,000 plants in the United States. This intensity is very low compared with general recommended practice—on the order of 20 foot-candles for active manufacturing areas.

ONLY THE BEGINNING

The leading industries, however, have not stopped at 20 foot-candles, but are pioneering in illumination standards far above the fairly conservative ones on which the recommended figures are based.

It might be assumed that daylight would be the best and cheapest method of lighting. Daylight is cheap only until it is brought indoors. Although the intensity out of doors on a clear day may be 10,000 foot-candles, it drops to a few hundred inside the windows and to 1 or 2 foot-candles in the center of the building.

Daylight intensity also varies throughout the day and the year. Daylight illumination in the winter months is considerably lower than in summer. In the modern factory, daylight alone is not dependable as the only source of illumination. No matter how a plant may be located with regard to natural light, there are always times when artificial illumination is necessary.

To provide satisfactory illumination in industrial interiors, three principal conditions must be met:

First there must be sufficient illumination for all visual tasks. For close visual work, such as fine assembling, etching, decorating, and inspection, an intensity of 20 to 30 foot-candles is required for comfortable vision. For industrial tasks that are less severe, between 10 and 20 foot-candles are required.

Equally important, glare must be absent. It may be defined as any bright light source within the field of vision that causes discomfort, annoyance, or eye fatigue. It may be caused by a bare lamp, a poorly designed lighting fixture, light from a window, or reflection.

The third important requisite is proper distribution and diffusion of light. Whether it be natural, artificial, or a combination of both, light should be distributed evenly over the entire area.

Nowhere has lighting a better chance to serve eyesight than in industry. Factory men, when appraising their lighting facilities, would do well to lift a page from the notebook of the eyesight specialist who, when fitting a person for glasses, really peers through the subject's eyes to study his vision faculties.

The right lamp in the right reflector will give between 200 and 500 foot-candles on the lathe, depending upon the distance the light source is fixed from the working plane

JUST HOW MUCH LIGHT?

How much light does the eye require for best seeing? How much light is required to save the workers' eyes from strain and fatigue, which in many instances are the cause of production waste and needless accidents? Ideal illumination for best seeing certainly is not found in the intensities of 3 to 8 foot-candles existing in many plants. Considering the eye only, and disregarding economics and engineering practicability, intensities on the order of 300 foot-candles are necessary to provide the most accurate and comfortable seeing for fine work.

As a rule, lighting levels of 100 foot-candles or more from general illumination are not practical. These high intensities, however, can usually be confined to a small working area. Throughout the remainder of the room good general illumination must be provided; it is the foundation of proper artificial lighting. Wherever close observation of delicate machinery or parts is required for either short or long periods, high-intensity lighting superimposed on the general illumination will assure the best vision.

Industrial illumination is usually divided into three classes according to the character of the work and the severity of the seeing task. Character of work, in turn, dictates the intensity or level of illumination. Knowing how much light the eye requires for a specific task, or level of illumination needed, the lighting installation is designed accordingly.

Various intensities are desirable for different industries. These values have

been standardized and will insure quick, accurate vision.

Except in warehouses and industrial areas used for similar purposes, the factory lighting installation usually involves all phases of lighting practice. General illumination, in which fixtures are supported from the ceiling on even spacings, constitutes the foundation of the installation. In local areas, higher levels of illumination superimposed upon the other are necessary because of the more exacting seeing requirements. Thus both general and local lighting are frequently needed in order to meet all requirements satisfactorily.

High-intensity lighting on the work may be obtained with floodlight or spotlight units. These units can be mounted high overhead and their light concentrated on jobs in the working plane, but because of maintenance inconveniences this method is not always practical. It is simpler to use local light sources attached to the machine or mounted within arm's reach so that they may be adjusted by the worker to suit his seeing requirements.

CHAPTER TWO

Lighting for Inspection

VISUAL inspection requires the most varied applications of fundamental lighting principles. Under average conditions, lighting levels of 20 to 30 foot-candles are justified. *But inspection work is seldom average work.*

Any inspection job that is preceded by many processing steps in which labor costs are relatively high and errors may well affect quality, price, or reputation deserves super-lighting, despite its cost.

LIGHTING MUST FIT CONDITIONS

Inspection lighting should be viewed from the standpoint of: (1) Composition; (2) finish; (3) form; (4) internal structure; (5) surface contour; (6) color.

Composition is the identification of surface defects by differences in light reflection. Well-diffused illumination is usually best, intensity varying with nature of product. An intensity of 100 foot-candles or more may be required to detect carbon particles on a gray-iron casting, whereas 10 to 20 foot-candles are satisfactory for detecting large black spots on a white background.

Every product may be classified as having either a dull or shiny finish. Dull finishes are easy to inspect under well-diffused illumination of adequate intensity. Shiny finishes reflect so much light that increasing the strength of the light source usually impairs visibility. To remove this condition, the light source should be kept larger, or apparently larger, than the object inspected. Then differences in the image of the light source on the object are indications of surface defects. Inspection of plated work is a common process where the class of finish dictates lighting practice.

Inspection for form or physical outline usually calls for diffused light except for small objects, which are inspected best with silhouette lighting. Since, in silhouette lighting, the inspector must look directly at the light source, low brightness is essential to eye comfort. Diffusing the light source will help, although too much diffusion will destroy a sharp outline.

Textiles, containers, and many other products are inspected efficiently under different forms of silhouette lighting.

Internal inspection with light is applicable only to translucent objects, such as glass, celluloid, and liquids. When the object is free from defects, the light passes through unaltered. Bubbles, foreign matter, cracks, or variations in thickness cause color changes, refraction, diffusion, and other disturbances in the light rays.

Products in this group often have shiny surfaces; hence overhead lighting is not always practical, unless the inspector can also view the product from above.

Slight variations in surface contour are easier to see with directional light, the intensity being of secondary importance. With linoleum, for example, blisters are the chief defect. Occasionally found on 9-ft. rolls hundreds of feet long, blisters may easily slip by the inspector who has not been given proper lighting facilities.

Color, as an inherent characteristic of most objects, is an important factor in inspection. Where the differences are slight, as in sorting buttons or cigars, and in linoleum manufacture or textile weaving, the spectral composition of the inspection light is critical.

The degree to which artificial light should approach daylight color depends entirely upon the industry and the importance of an exact match. Daylight blue lamps or their equivalent are a step in the right direction and in many cases are satisfactory.

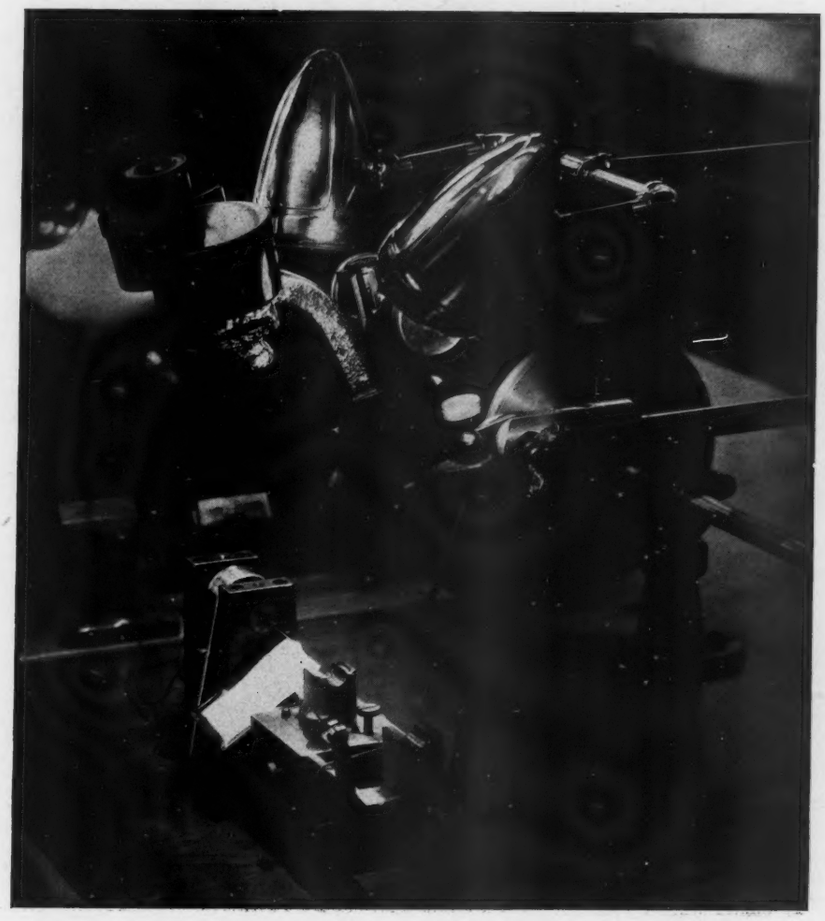
WATCH THE COLOR OF THE LIGHT

Color is sometimes involved in plating inspection—for example, chromium and nickel. Both are white, but chromium has a slight bluish cast, whereas nickel is slightly yellowish.

Jewelry, especially gold, also presents color problems. Wrist-watch bands of gold may be white, green-yellow, or some intermediate shade. They must be carefully lighted to facilitate the accurate assembly and matching of parts.

The two most important conditions in color inspection are uniformity and

How closely artificial light should approach daylight color depends entirely upon the industry and the importance of an exact match. In this printing plant the daylight-blue glass color plate is used where the colors of four-color advertisements must measure up to exacting inspection standards



Two tiny lighting units, similar to automobile cowl lights, produce a pin point of light for the microscopic inspection of diamonds, which are later drilled to form the dies through which filament wire is drawn

reproducibility. The first essential is to select a standard light and then reproduce it at all inspection points. Day and night shifts on the same inspection job require light of similar spectral composition, which usually means eliminating daylight entirely. Obviously, 200 or 300 foot-candles of daylight mixed with 50 or 100 foot-candles of artificial daylight are not the equivalent of the same 50 or 100 foot-candles of artificial daylight alone.

CHAPTER THREE

Correct Lamps Must Be Used

SELECTION of the lamps to be used in industrial lighting installations can hardly be given too much care. Using any old size of lamp in the lighting reflector, just because it is a light source, is about as ridiculous as wearing any old size of hat just because it is a headpiece.

If a lamp is too small for the reflector, the light is confined to a limited area immediately underneath, greatly reducing the efficiency of the lighting unit. When a lamp is too large for the reflector, it protrudes beyond the bottom rim, the reflector directs less light downward; therefore glare is produced.

For example, a 200-watt RLM reflector with a lamp of corresponding wattage will have a light output efficiency of about 73.5 per cent. If a 150-watt lamp is used in the same reflector, the output efficiency drops to about 62 per cent. To prevent such losses, make sure that the proper reflector holder is used, check up the socket position therein, and guard against the careless interchange of bulbs and accessories.

Out of about 3,000 different kinds of incandescent lamps manufactured today, only half a dozen or so come under the jurisdiction of the plant electrical department. All standard Mazda lamps up to and including the 150-watt rating are supplied with inside-frosted bulbs. Lamps of higher wattage are commonly supplied with clear bulbs, but may be obtained on special order with inside-frosted, white-bowl, or daylight-blue bulbs.

White-bowl lamps are made in sizes ranging from 150 watts upward. The white coating conceals the filament and minimizes its glare in open-type reflectors. This type of lamp is recommended for low mounting heights, where the brilliant filament glare may disturb vision. Obviously, reflectors mounted more than 12 ft. above the floor do not come within this classification.

Daylight-blue lamps filter out some of the red and yellow rays to produce a whiter light that resembles the color of daylight. From an economical standpoint, however, daylight-blue lamps are seldom used, except for special applications where color matching is paramount. To use them for general illumination results in high operating costs because the blue glass absorbs approximately 35 per cent of the light generated. Therefore, for a specific level of illumination in the working area, lamps of higher wattage would be required to compensate for loss of light by absorption.

BETTER LARGE THAN SMALL

Large lamps rather than an equivalent wattage in smaller lamps, so long as they are consistent with uniformity of distribution, absence of glare, flexibility of control, and safety of support, should always be used for general illumination. The reason is that lamps of higher wattage operate at higher efficiency and therefore give more lumens of light per dollar of lamp cost. Comparative outputs in lumens per watt of low- and high-wattage lamps used for general lighting purposes are given in the table below:

Lamp Size, Watts	*Initial Output, Lumens*	*Initial Lumens per Watt*
60	762	12.7
100	1,530	15.3
200	3,400	17.0
500	9,800	19.6
1,000	20,700	20.7

A new 1,000 watt tubular lamp has recently been announced. It has a T-24 tubular bulb made of Pyrex glass, inside frosted. Less than half the size of the 1,000-watt, PS-52 bulb Mazda lamp now used for general illumination in large industrial and commercial installations, it will permit the use of small reflectors and accessories, and thereby contribute to lower installation cost. Moreover, the Pyrex bulb is less likely to be broken by snow and rain, encountered in outdoor installations, thus obviating the need for costly waterproof equipment.

A structural member has been incorporated within the bulb to collect and localize the vaporized tungsten that causes blackening. This feature minimizes the gradual depreciation of light output, which is a serious problem in the conventional high-wattage lamps.

The high-intensity mercury vapor lamp, introduced two years ago and now coming into wide use for industrial lighting, is made in three different sizes—namely, 400, 250, and 85 watts. Each of these lamps requires a transformer or reactor for operation.

In the heavy industries, such as iron and steel mills, boiler works, machine shops, automobile plants, and foundries, where the color of the light is not a factor, the high-intensity mercury vapor lamp has several advantages. Producing light at about twice the efficiency of the tungsten-filament incandescent lamps, this new lamp produces illumination of a distinctive color quality that has been found desirable for certain manufacturing areas. All objects seen in this light stand out in sharp detail, contributing to an ease of vision which results in less eye fatigue at the end of the day—a factor of importance in the mental attitude of the worker.

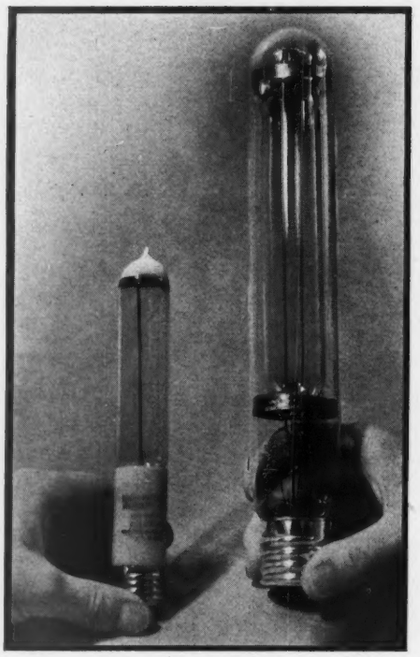
Since these lamps are relatively new, their field of use has not yet reached full development, although they are rapidly finding application for factory lighting. In a retail store the color of the light would distort the color of merchandise, but this characteristic meets with little or no objection in the majority of factory interiors.

Some authorities, however, believe that combination lighting, which uses mercury lamps in conjunction with tungsten-filament lamps, has a distinct field of use, especially in industrial areas where the character of the products and processes is such that artificial daylight results in better quality of inspection and production.

Light from the ordinary Mazda lamp is deficient in violet, blue, and green, and since mercury light is particularly rich in these colors, the combination of the two gives a light similar in quality to daylight.

It is the practice to mix approximately equal quantities (lumens) of light from tungsten-filament incandescent and mercury lamps, using one fixture for both sources. It may also be done by using a mixed system in which mercury and tungsten-filament lamps are installed in staggered positions.

Combination units resemble the Glassteel Diffuser in general appearance, whereas the other types of reflectors for mercury lamps are much like those in which tungsten-filament lamps are used.



New 250-watt high-intensity mercury lamp (left) is about one-third the size of the 400-watt design. It produces 7,500 lumens of light for an average life of 2,000 hours, and can be burned in any position. Because of its single clear glass bulb, as contrasted to the double bulb of the 400-watt lamp, it is susceptible to drafts and must be operated in inclosing units to assure maximum output

CHAPTER FOUR

Fit Reflectors to Conditions

MANY TYPES and kinds of reflecting equipment are used in industrial lighting, although the tendency is to standardize on equipment wherever feasible. Porcelain-enameled, steel reflectors are in popular favor because of their durability and efficiency.

The RLM Standard Dome Reflector, one of this type, is extensively used with satisfactory results. This reflector gives a wide distribution of light, but is so designed that glare is minimized. Where necessary to mount it 15 ft. or less from the floor, the white-bowl or inside-frosted lamp should be used to eliminate the glare of the bright filament.

FOR LIGHTS THAT ARE LOW

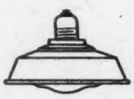
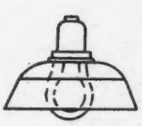
Where soft, well-diffused illumination is desired, use the Glassteel Diffuser in place of the RLM Standard Dome Reflector. This unit consists of a porcelain-enameled steel reflector and a diffusing glass globe which incloses the lamp. Small openings at the top of this reflector permit a little light to pass through and illuminate the ceiling, reducing the contrast of bright fixtures against a dark background.

High industrial interiors equipped with traveling cranes usually require that the lighting equipment be mounted overhead. When the cranes are 20 ft. or more above the floor, the lighting units should provide a fairly concentrated light distribution. Reflectors that will do this are the high-bay or the high-mounting design. They direct the maximum amount of light directly downward on the working areas, where it is needed most. Made either of polished metal, prismatic glass, mirrored glass, or aluminum with a special high-efficiency finish (Alzak), they give accurate directional control of light and suitable distribution for lighting high, narrow interiors. In such areas, however, it is advisable to install angle-type reflectors along the sides in order

TABLE I. Guide to Selection of Lamps and Reflectors

Kind and Size of Lamp				*Reflector Size*	*Foot-Candles at Distance from Work*	
Watts	*Volts*	*Bulb*	*Finish*		*5 in.*	*10 in.*
15	115	A-17	I. F.	1	110	30
25	115	A-19	I. F.	2	222	65
40	115	A-19	I. F.	2	354	110
50 R. S.	115	A-19	I. F.	2	342	110
50	115	A-21	I. F.	3	428	169
60	115	A-21	I. F.	3	592	224

TABLE 2. Typical Industrial Reflectors

	RLM DOME REFLECTORS Most widely used for providing general illumination in industrial interiors. To minimize glare use a White Bowl lamp
	**GLASSTEEL DIFFUSERS** Used where it is desirable to obtain a softer, better diffused light than that provided by the RLM Reflector
	HIGH MOUNTING REFLECTORS Designed for use in industrial interiors where the mounting height is 20 ft. or over
	DEEP BOWL REFLECTORS Their chief application is in places where a strong local light must be provided with more than ordinary shielding of the light source
	ANGLE REFLECTORS Used for installations where lighting must be done from the side, or for the illumination of vertical surfaces
	**VAPOR PROOF UNITS** Designed for use in industrial interiors to prevent inflammable, explosive or corrosive dusts and vapors from reaching the lamp and socket. Should be fitted with a Dome Reflector

to build up the vertical illumination near the floor.

The three types of reflectors mentioned are the most widely used for general industrial lighting, but a number of other designs are available for specific applications, such as local lighting and floodlighting.

IT'S NOT DONE NOW

The old-time practice of doing close work at benches or machines located near windows to secure maximum daylight has given way to the scientific layout so necessary to efficiency. Consequently, it is essential to plan local lighting for the work to be done. When a worker must keep his eyes directed for long periods on a delicate assembly job, or on rigid inspection procedure, only good local lighting will permit him to see accurately.

Small lamps of 25, 40, and 60 watts may be used in these light sources to give the desirable high intensities and at the same time afford economical operation. When placed at distances of 6 in. to 2 ft. from the work, intensities from 50 to as high as 500 foot-candles may be obtained. By bringing the light source close to the work, practically all disturbing glare can be eliminated, particularly when the lamps and reflectors are mounted on adjustable arms, because the unit can be placed so that the worker's eyes are behind the light source.

Local lighting with bare lamps is not only bad practice, but it is also uneconomical. Obviously more than half the light generated by the lamp radiates away from the working plane and is therefore wasted. Every bare lamp should be protected with a reflector that minimizes the glare and recaptures the wasted light. A reflector will increase the illumination on the work by 20 to 30 per cent.

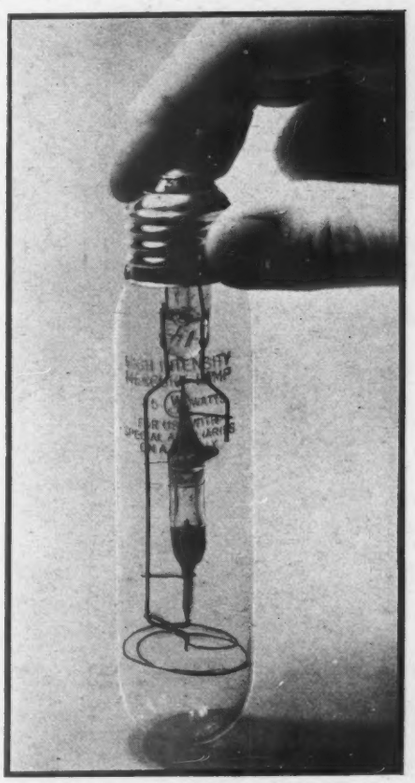
MATCH REFLECTOR AND LAMP SIZES

A common fault seen in local lighting installations is the use of incorrect lamp sizes in reflectors. If the lamp is too large, it will extend beyond the mouth of the reflector, causing glare and wasting light. The lamp may give sufficient light for the work, but the reflector is too small to control it properly.

In one instance where the light source was mounted 10 in. away from the work, a 50-watt lamp was found in a reflector that was too small. The bulb projected below the opening of the reflector, and of course light was wasted. The intensity on the working plane was only 120 foot-candles. By replacing this reflector with a larger one the intensity on the work was increased to 160 foot-candles.

In another instance, where the light source was again 10 in. from the work, a 60-watt lamp was used in a reflector that was too small. The intensity on the working plane was 154 foot-candles.

New 85-watt high-intensity mercury lamp produces as much light as conventional 200-watt incandescent lamp



By replacing the reflector with one of the proper size, the intensity jumped to 224 foot-candles, an increase of 45 per cent.

The shape or contour of the bowl reflectors for local lighting is designed to produce a definite distribution of light. The size of the reflector is determined by the wattage that gives the required intensity of light (see Table I). When both are in correct relationship, the light center will be in such a position that it gives the best possible distribution of light at maximum efficiency and with a minimum of glare.

There are three general sizes of bowl reflectors available for local lighting purposes. All three have a porcelain-enamel finish, green outside and white inside.

GENERAL PLUS LOCAL ILLUMINATION

The size of the reflector depends upon the character of the work to be illuminated. For lighting latnes and most one-operator machinery, the small reflector will usually prove satisfactory. In such cases the reflector may be mounted on an adjustable arm so that it can be moved to and from the work as seeing conditions demand. Where the work is of such nature as to require higher intensity, or a high intensity over a wider area, the larger reflector is suggested because it permits the use of a larger lamp.

This reflector is also recommended for fixed installations.

Often it is desirable to obtain a high level of illumination over a long row of work benches or inspection tables that cannot be effectively lighted to the proper intensity from the general lighting installation. In such instances the larger bowl reflectors can be installed on close spacings at low mounting heights. In this way it is possible to provide intensities of 30 to 60 foot-candles on the working plane, or two to three times the level produced by the usual general illumination system. Each individual reflector in such an installation may have its own control switch.

Intensity of illumination at any point may be readily checked with a meter of this kind. Surveys made with this instrument frequently reveal the need of changes in lighting conditions that will make it possible for the workers to perform their jobs much more efficiently

When directed and diffused by the reflector, the proper lamp gives glareless, shadowless illumination, greatly increasing the accuracy and safety of vision

CHAPTER FIVE

Let's Plan A Lighting Installation

TO PROVIDE suitable illumination for any particular work or place, a lighting system must be designed especially for that application. Illumination can, and should be, calculated precisely. There are two methods by which this may be done, the "point by point" and the "flux-of-light" or lumen methods.

FROM MANY POINTS

In the point-by-point method the illumination at any spot in a working area can be determined by mathematical computations involving the candlepower distribution of the luminaire and its position with reference to the point in question. The same procedure is necessary for all lighting units sending illumination to that particular point. The sum total of the values from all units (and from all lighted surfaces and reflections, if high accuracy is desired) is the foot-candle illumination at that point.

If the illumination at an infinite number of points in any area is calculated by this method, the average of these points will be representative of the average illumination for the area. This method involves a complicated but sometimes necessary procedure to follow for certain types of installations.

To simplify the computation of general lighting installations, the flux-of-light or lumen method was introduced. This method assumes an average of intensity of illumination over a given area. Calculations involved are not difficult, but at the same time allow for all variables affecting the illumination, such as type of lighting unit, general proportions of room, color of walls and ceilings, and maintenance conditions.

THIS METHOD IS SIMPLER

The simplicity of calculating industrial lighting installations by the flux-of-light method is seen in the following procedure, which is divided into

(*Continued on page S-302*)

TABLE III. Recommended Standards of Illumination for Industrial Interiors

(These values represent order of magnitude rather than exact levels)

	Foot-Candles
Aisles, Stairways, Passageways	2
Assembly:	
Rough	10
Medium	20
*Fine	50–100
*Extra Fine	100 or more
Automobile Manufacturing:	
*Assembly Line	50–100
Frame Assembly	15
Body Manufacturing—Assembly	20
*Finishing and Inspecting	100 or more
Bakeries	20
Book Binding:	
Folding, Assembling, Pasting, etc.	10
Cutting, Punching and Stitching	20
Embossing	20
Breweries:	
Brew House	5
Boiling, Keg Washing and Filling	10
Bottling	15
Candy Making	20
Canning and Preserving	20
Chemical Works:	
Hand Furnaces, Boiling Tanks, Stationary Driers, Stationary and Gravity Crystallizers, Mechanical Furnaces, Generators, Stills	5
Mechanical Driers, Evaporators, Filtration, Mechanical Crystallizers, Bleaching	10
Tanks for Cooking, Extractors, Percolators, Nitrators, Electrolytic Cells	15
Clay Products and Cements:	
Grinding, Filter Presses, Kiln Rooms	5
Molding, Pressing, Cleaning and Trimming	10
Enameling	15
Color and Glazing	20
Cloth Products:	
Cutting, Inspecting, Sewing—Light Goods	20
*Dark Goods	100 or more
Pressing, Cloth Treating (Oil Cloth, etc.)—Light Goods	10
Dark Goods	20
Coal:	
Breaking, Washing and Screening	5
Construction—Indoor:	
General	10
Dairy Products	20
Elevators:	
Freight and Passenger	10
***Engraving**	100 or more
Forge Shops and Welding	10
Foundries:	
Charging Floor, Tumbling, Cleaning, Pouring and Shaking Out	5
Rough Molding and Core Making	10
Fine Molding and Core Making	20
Garages—Automobile:	
Storage—Live	10
Dead	2
*Repair Department and Washing	30–50

	Foot-Candles
Glass Works:	
Mix and Furnace Rooms, Pressing and Lehr, Glass Blowing Machines	10
Grinding, Cutting Glass to Size, Silvering	20
*Fine Grinding, Polishing, Beveling, Etching and Decorating	30–50
*Inspection	50–100
Glove Manufacturing:	
Light Goods—Cutting, Pressing, Knitting, Sorting	10
Stitching, Trimming and Inspecting	20
Dark Goods—Cutting, Pressing, Knitting, Sorting	20
*Stitching, Trimming and Inspecting	100 or more
Hangars—Aeroplane:	
Storage—Live	10
*Repair Department	30–50
Hat Manufacturing:	
Dyeing, Stiffening, Braiding, Cleaning and Refining—Light	10
Dark	20
Forming, Sizing, Pouncing, Flanging, Finishing and Ironing—Light	15
Dark	30
Sewing—Light	20
*Dark	100 or more
Ice Making—Engine and Compressor Room	10
Inspection:	
*Rough	10
*Medium	20
*Fine	50–100
*Extra Fine	100 or more
Jewelry and Watch Manufacturing	100 or more
Laundries and Dry Cleaning	20
Leather Manufacturing:	
Vats	5
Cleaning, Tanning and Stretching	10
Cutting, Fleshing and Stuffing	15
Finishing and Scarfing	20
Leather Working:	
Pressing, Winding and Glazing—Light	10
Dark	20
Grading, Matching, Cutting, Scarfing, Sewing—Light	20
*Dark	100 or more
Locker Rooms	5
Machine Shops:	
Rough Bench and Machine Work	10
Medium Bench and Machine Work, Ordinary Automatic Machines, Rough Grinding, Medium Buffing and Polishing	20
*Fine Bench and Machine Work, Fine Automatic Machines, Medium Grinding, Fine Buffing and Polishing	50–100
*Extra Fine Bench and Machine Work, Grinding—Fine Work	100 or more
Meat Packing:	
Slaughtering	10

	Foot-Candles
Cleaning, Cutting, Cooking, Grinding, Canning, Packing	20
Milling—Grain Foods:	
Cleaning, Grinding and Rolling	10
Baking or Roasting	20
Flour Grading	30
Offices:	
Private and General—No Close Work	10
Close Work	20
Drafting Rooms	30
Packing and Boxing	10
Paint Manufacturing	10
Paint Shops:	
Dipping, Spraying, Firing	10
Rubbing, Ordinary Hand Painting and Finishing	20
*Fine Hand Painting and Finishing	50–100
*Extra Fine Hand Painting and Finishing (Automobile Bodies, Piano Cases, etc.)	100 or more
Paper Box Manufacturing:	
Light	10
Dark	20
Storage and Stock	5
Paper Manufacturing:	
Beaters, Grinding, Calendering	10
Finishing, Cutting, Trimming	20
Plating	10
Polishing and Burnishing	15
Power Plants, Engine Rooms, Boilers:	
Boilers, Coal and Ash Handling, Storage Battery Rooms	5
Auxiliary Equipment, Oil Switches and Transformers	10
Switchboards, Engines, Generators, Blowers, Compressors	15
Printing Industries:	
Matrixing and Casting	10
Miscellaneous Machines	15
Presses and Electrotyping	20
*Lithographing	50–100
*Linotype, Monotype, Typesetting, Imposing Stone, Engraving	50–100
*Proof Reading	100 or more
Receiving and Shipping	10
Rubber Manufacturing and Products:	
Calenders, Compounding Mills, Fabric Preparation, Stock Cutting, Tubing Machines, Solid Tire Operations, Mechanical Goods Building, Vulcanizing	10
Bead Building, Pneumatic Tire Building and Finishing, Inner Tube Operation, Mechanical Goods Trimming, Treading	20
Sheet Metal Works:	
Miscellaneous Machines, Ordinary Bench Work	15
Punches, Presses, Shears, Stamps, Welders, Spinning, Medium Bench Work	20
*Tin Plate Inspection	30–50
Shoe Manufacturing:	
Hand Turning, Miscellaneous Bench and Machine Work	10

(Continued on next page)

	Foot-Candles
Inspecting and Sorting Raw Material, Cutting and Stitching—	
Light	20
*Dark	100 or more
Lasting and Welting	20
Soap Manufacturing:	
Kettle Houses, Cutting, Soap Chip and Powder	10
Stamping, Wrapping and Packing, Filling and Packing Soap Powder	20
Steel and Iron Mills, Bar, Sheet and Wire Products:	
Soaking Pits and Reheating Furnaces	5
Charging and Casting Floors	10
Muck and Heavy Rolling, Shearing, rough by gauge, Pickling and Cleaning	10
*Plate Inspection and Chipping	30–50
Automatic Machines, Light and Cold Rolling, Wire Drawing, Shearing, fine by line	15
Stone Crushing and Screening:	
Belt Conveyor Tubes	5
Main Line Shafting Spaces, Chute Rooms, Inside of Bins	5
Primary Breaker Room, Auxiliary Breakers under Bins	5
Screens	10
Storage Battery Manufacuring:	
Molding of Grids	10
Store and Stock Rooms:	
Rough Bulky Material	2
Medium or Fine Material requiring care	10
Structural Steel Fabrication	10
Sugar Grading	30
Testing:	
Rough	10
Fine	20

	Foot-Candles
*Extra Fine, Instruments Scales, etc.	100 or more
Textile Mills:	
Cotton—	
Opening and Lapping, Carding, Drawing, Roving, Dyeing	10
Spooling, Spinning, Drawing-in, Warping, Weaving, Quilling, Inspecting, Knitting, Slashing (over beam end)	20
Silk—	
Winding, Throwing, Dyeing	15
Quilling, Warping, Weaving, Finishing—	
Light Goods	15
Dark Goods	30
Woolen—	
Carding, Picking, Washing, Combing	10
Twisting, Dyeing	10
Drawing-in, Warping—	
Light Goods	15
Dark Goods	30
Weaving—	
Light Goods	15
Dark Goods	30
Knitting Machines	20
Tobacco Products:	
Drying, Stripping, General	10
*Grading and Sorting	100 or more
Toilet and Wash Rooms	5
Upholstering:	
Automobile, Coach, Furniture	20
Warehouses	5
Woodworking:	
Rough Sawing and Bench Work	10
Sizing, Planing, Rough Sanding, Medium Machine and Bench Work, Gluing, Veneering, Cooperage	20
Fine Bench and Machine Work, Fine Sanding and Finishing	30

* Illumination of this order may in some instances be provided from a general lighting system. In other cases it will be found more economical to provide a combination of general lighting plus supplementary. Direction of light, diffusion, eye protection, study of direct and reflected glare, as well as elimination of objectionable shadows are all vitally important and must be considered.

four steps and involves use of the accompanying tables. These steps are:

1. Determining Foot-Candle Illumination. The foot-candle values of illumination which experience shows to be desirable for quick and comfortable vision have been determined and are given in Table III. Where any particular location or operation is not listed, the values for a comparable place can be used. The foot-candle values for general illumination are given on an average horizontal working place 30 in. from the floor, the accepted engineering standard.

2. Selecting the Type of Lighting Unit. Character of work to be performed, the construction of the room or building, and the color of walls and ceilings determine to a great extent the type of lighting equipment to be selected.

In industrial interiors where maximum lighting efficiency is desired and appearance is a secondary factor, the open-bottom reflectors, such as the RLM Standard Dome, prismatic-glass industrial reflectors, high-mounting reflectors, or even angle-type reflectors for special applications, should be used.

When industrial reflectors are mounted less than 15 ft. from the floor, the lamp filament may come within the field of vision and produce glare. To prevent this, use white-bowl or inside-frosted Mazda lamps. Other variables influencing the choice of

(Continued on page S307)

TABLE IV. Room and Maintenance Conditions

Proportions of Room	*Color of Ceiling and Upper Sidewalls*	*CONDITIONS FACTOR*			
		Direct Lighting		*Indirect and Semi-Indirect Lighting*	
		Maintenance of Equipment		*Maintenance of Equipment*	
		Very Good	*Fair*	*Very Good*	*Fair*
Width Approximately Four or More Times Ceiling Height	Light	Favorable	Favorable	Favorable	Favorable
	Medium	Favorable	Favorable	Favorable	Average
	Dark	Favorable	Average	Unfavorable	Unfavorable
Width Approximately Twice Ceiling Height	Light	Favorable	Average	Favorable	Average
	Medium	Favorable	Average	Average	Unfavorable
	Dark	Average	Unfavorable	Unfavorable	Impracticable
Width Approximately Equal to Ceiling Height	Light	Average	Unfavorable	Average	Unfavorable
	Medium	Unfavorable	Unfavorable	Unfavorable	Impracticable
	Dark	Unfavorable	Unfavorable	Unfavorable	Impracticable

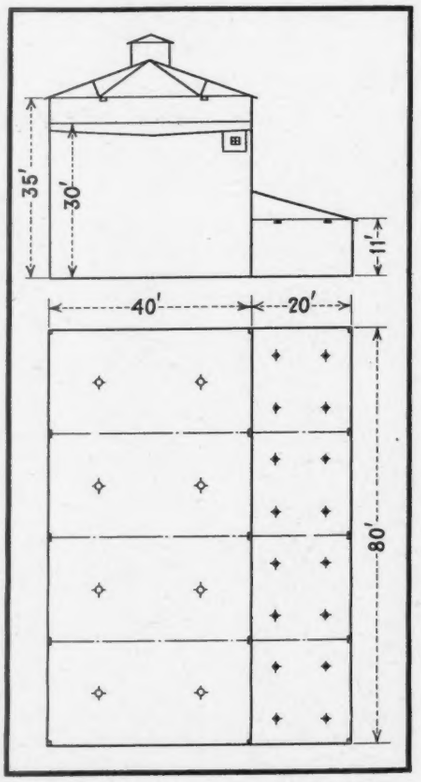
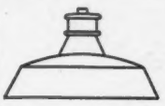


FIGURE 1. Plan and elevation of an assembling plant for which the lighting is planned in the accompanying text

TABLE V. Design Data for RLM Dome Reflectors

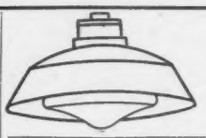


These data apply to RLM Dome Reflectors equipped with white bowl Mazda lamps, or slightly etched glass cover plate or glass ring when used with High Intensity Mercury Vapor Lamps. For clear or inside frosted Mazda lamps increase the average foot-candle value 10 per cent.

Distance from Underside of Reflector to Floor to Be Not Less than (Ft.)	Approx. Spacing (Ft.)	Area per Outlet (Sq. Ft.)	Conditions Factor	Average Foot-Candles								
				Mazda Lamp							Mercury Lamp	
				100 Watt	150 Watt	200 Watt	300 Watt	500 Watt	750 Watt	1000 Watt	250 Watt	400 Watt
			Fav.	8–10	15–18	21–26	33–41	59–74	.....	.....	40–52	.....
7½	7¾x 7¾	55–65	Aver.	6–8	11–15	16–21	25–33	45–59	.....	.....	30–40	.....
			Unfav.	5.5–6.5	9–11	13–16	21–25	38–45	.....	.....	24–31	.....
			Fav.	7–9	13–16	18–22	29–35	52–63	77–94	.....	34–42	.....
8½	8½x 8½	65–75	Aver.	6–7	10–13	13–18	21–29	38–52	56–77	.....	25–34	.....
			Unfav.	5–6	8–10	11–13	17–21	30–38	45–56	.....	20–25	.....
			Fav.	8–8	11–14	15–19	24–30	43–54	64–80	.....	30–38	.....
8½	9 x 9	75–85	Aver.	5–6	8–11	12–15	19–24	34–43	50–64	.....	22–29	.....
			Unfav.	4–5	7–8	10–12	16–19	29–34	43–50	.....	18–22	.....
			Fav.	5–7	10–12	14–17	22–27	40–49	59–73	.....	27–34	.....
9	9½x 9½	85–95	Aver.	4–5	8–10	11–14	18–22	32–40	48–59	.....	20–27	.....
			Unfav.	3.5–4.0	6–8	9–11	14–18	25–32	37–48	.....	16–20	.....
			Fav.	4–6	8–10	12–15	21–26	38–47	56–70	79–99	25–32	.....
9½	10 x10	95–110	Aver.	3.5–4.0	6–8	10–12	16–21	29–38	43–56	61–79	18–25	.....
			Unfav.	3.0–3.5	5–6	8–10	13–16	23–29	34–43	48–61	16–18	.....
			Fav.	4–5	7–9	10–13	18–22	32–40	48–59	68–84	21–27	48–59
10	11 x11	110–125	Aver.	3.5–4.0	6–7	8–10	14–18	25–32	37–48	52–68	16–21	37–48
			Unfav.	2.5–3.5	5.0–5.5	7–8	12–14	22–25	33–37	47–52	13–16	33–37
			Fav.	3.5–4.0	6–8	9–11	15–19	27–34	40–50	57–71	18–24	40–50
10½	11½x11½	125–145	Aver.	3.0–3.5	5–6	7–9	12–15	22–27	33–40	47–57	14–18	33–40
			Unfav.	2.5–3.0	4–5	6–7	10–12	18–22	27–33	38–47	11–14	27–33
			Fav.	3.0–3.5	5–7	7–9	13–17	23–30	34–45	48–64	17–21	34–45
11½	12½x12½	145–170	Aver.	2.5–3.0	4–5	6–7	10–13	18–23	27–34	38–48	13–17	27–34
			Unfav.	2.0–2.5	3.5–4.0	5–6	8–10	16–18	24–27	34–38	10–13	24–27
			Fav.	.....	4–6	6–8	11–14	20–25	30–37	42–52	14–17	30–37
11½	13½x13½	170–200	Aver.	.....	3.5–4.0	5–6	8–11	16–20	24–30	34–42	10–14	24–30
			Unfav.	.....	3.0–3.5	4–5	7–8	13–16	19–24	27–34	9–10.5	19–24
			Fav.	.....	3.5–4.0	5–7	10–12	17–22	25–33	35–47	11–14	25–33
12½	14¾x14¾	200–230	Aver.	.....	3.0–3.5	4.5–5.5	7–10	13–17	19–25	27–35	9–11	19–25
			Unfav.	.....	2.5–3.0	3.5–4.0	6–7	11–13	16–19	23–27	7.5–9	16–19
			Fav.	.....	3.0–3.5	4–6	8–10	15–19	22–28	31–40	10.5–12.5	22–28
13	15½x15½	230–260	Aver.	.....	2.5–3.0	4.0–4.5	6–8	12–15	18–22	25–31	8.5–10	18–22
			Unfav.	.....	2.0–2.5	3.5–4.0	5.5–6.5	10–12	15–18	21–25	6–7.5	15–18
			Fav.	.....	.....	4–5	7–9	13–17	19–25	27–35	10–11	19–25
13½	16¾x16¾	260–300	Aver.	.....	.....	3.5–4.0	6–7	10–13	15–19	21–27	7–8.5	15–19
			Unfav.	.....	.....	3.0–3.5	5–6	9–10	13–15	18–21	5.5–6.5	13–15
			Fav.	.....	.....	3.5–4.0	6–8	12–14	18–21	25–30	7–10	18–21
14½	18 x18	300–340	Aver.	.....	.....	3.0–3.5	5–6	9–12	18–18	18–25	5.5–7	13–18
			Unfav.	.....	.....	2.5–3.0	4–5	7–9	10–13	14–18	5–5.5	10–13
			Fav.	.....	.....	3.0–3.5	5–7	10–12	15–18	21–25	6.5–8.5	15–18
15½	19 x19	340–390	Aver.	.....	.....	2.5–3.0	4–5	7–10	10–15	14–21	5–5.5	10–15
			Unfav.	.....	.....	2.0–2.5	3.5–4.0	6–7	9–10	13–14	4–5	9–10
			Fav.	.....	.....	.....	4–6	9–11	13–16	18–23	5.5–7	13–16
16½	20½x20½	390–440	Aver.	.....	.....	.....	3.5–4.0	7–9	10–13	14–18	4–5.5	10–13
			Unfav.	.....	.....	.....	3.0–3.5	5–6	7–9	10–13	3.5–4	7–9
			Fav.	.....	.....	.....	4–5	8–10	12–15	17–21	5–5.5	12–15
17	21¾x21¾	440–500	Aver.	.....	.....	.....	3.0–3.5	6–8	9–12	13–17	3.5–5	9–12
			Unfav.	.....	.....	.....	2.5–3.0	4–5	6–7	8–10	3–3.5	6–7

Mount Units 12 ft. High Wherever Possible

TABLE VI. Design Data For Glassteel Diffusers



These data apply to Glassteel Diffusers equipped with white diffusing globes. For Glassteel Diffusers equipped with daylight blue globes, reduce the average foot-candle values as listed by 35 per cent.

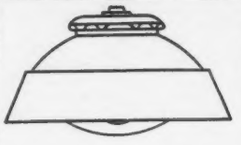
Distance from Underside of Reflector to Floor to Be Not Less than (Ft.)	Approx. Spacing (Ft.)	Area per Outlet (Sq. Ft.)	Conditions Factor	Average Foot-Candles							
				Mazda Lamps						Mercury Lamps	
				150 Watt	200 Watt	300 Watt	500 Watt	750 Watt	1000 Watt	250 Watt	400 Watt
7½	7¾ x 7¾	55–65	Fav.	13–16	18–23	29–37	52–66	.....	.....	40–52	.....
			Aver.	10–13	14–18	22–29	40–50	.....	.....	30–40	.....
			Unfav.	8–10	11–14	17–22	30–40	.....	.....	24–31	.....
8½	8½ x 8½	65–75	Fav.	11–14	15–19	24–30	43–54	64–80	.....	34–42	.....
			Aver.	8–11	11–15	18–24	32–40	48–59	.....	25–34	.....
			Unfav.	7–8	9–11	14–18	25–32	37–48	.....	20–25	.....
8½	9 x 9	75–85	Fav.	10–12	13–17	21–27	38–49	57–73	.....	30–38	.....
			Aver.	8–10	10–13	16–21	29–38	43–56	.....	22–29	.....
			Unfav.	6–8	8–10	13–16	23–29	34–43	.....	18–22	.....
9	9½ x 9½	85–95	Fav.	8–10	12–15	19–24	34–43	51–64	72–90	27–34	.....
			Aver.	6–8	9–12	14–19	25–35	37–52	52–74	20–27	.....
			Unfav.	5–6	7–9	11–14	20–25	30–37	43–53	16–20	.....
9½	10 x10	95–110	Fav.	7–9	11–13	18–23	32–41	48–61	68–87	25–32	.....
			Aver.	5–7	8–11	13–18	23–32	34–48	48–68	18–25	.....
			Unfav.	4–5	6–8	11–13	20–23	30–34	43–48	16–18	.....
10	11 x11	110–125	Fav.	6–8	9–11	15–19	27–34	40–50	57–71	21–27	44–55
			Aver.	5–6	7–9	11–15	20–27	30–40	43–57	16–21	33–44
			Unfav.	4–5	5–6	9–11	16–20	24–30	34–43	13–16	27–34
10½	11½x11½	125–145	Fav.	5–7	8–10	13–17	23–30	34–45	48–64	18–24	37–50
			Aver.	4–5	6–8	10–13	18–23	27–34	38–48	14–18	30–37
			Unfav.	3–4	4.5–5.5	8–10	14–18	21–27	30–38	11–14	23–30
11½	12½x12½	145–170	Fav.	4–6	6.5–8.0	12–15	21–26	31–39	44–55	17–21	34–43
			Aver.	3–4	5–6	9–12	16–21	24–31	34–44	13–17	26–34
			Unfav.	2.5–3.5	4–5	7–9	13–16	19–24	27–34	10–13	21–26
11½	13½x13½	170–200	Fav.	3.5–5.0	6–7	10–12	18–23	27–34	38–48	14–17	30–37
			Aver.	3.0–3.8	4–5	7–10	13–18	19–27	27–38	10–14	21–30
			Unfav.	2.5–3.0	3.5–4.0	6.5–7.5	10–13	15–19	21–27	9–10.5	17–21
12½	14¾x14¾	200–230	Fav.	3.5–4.0	5–6	8–10	15–19	22–28	31–40	11–14	24–31
			Aver.	2.8–3.5	3.5–4.0	6.5–8.0	11–15	16–22	23–31	9–11	18–24
			Unfav.	2.0–2.5	3.0–3.5	5.5–6.5	9–11	13–16	18–23	7.5–9	14–18
13	15½x15½	230–260	Fav.	.....	4–5	7.5–9.0	13–17	19–25	27–35	10.5–12.5	21–28
			Aver	.....	3–4	6–7	10–13	15–19	21–27	8.5–10	17–21
			Unfav.	.....	2.5–3.0	4.5–5.5	8–10	12–15	17–21	6–7.5	13–17
13½	16¾x16¾	260–300	Fav.	.....	3.5–4.0	7–8	12–15	18–22	25–31	10–11	20–24
			Aver.	.....	3.0–3.5	5–6	9–12	13–18	18–25	7–8.5	14–20
			Unfav.	.....	2.0–2.5	4.0–4.5	7–9	10–13	14–18	5.5–6.5	11–14
14½	18 x18	300–340	Fav.	.....	.....	5–7	10–12	15–18	21–25	7–10	17–20
			Aver.	.....	.....	4–5	8–10	12–15	17–21	5.5–7	13–17
			Unfav.	.....	.....	3.5–4.0	6–8	9–12	13–17	5–5.5	10–13
15½	19 x19	340–390	Fav.	.....	.....	4.5–6.0	9–11	13–16	18–23	6.8–8.5	14–18
			Aver.	.....	.....	3.5–4.0	7–9	10–13	14–18	5–5.5	11–14
			Unfav.	.....	.....	3.0–3.5	5.5–6.5	8–10	11–14	4–5	9–11
16½	20½x20½	390–440	Fav.	.....	.....	4–5	8–10	12–15	17–21	5.5–7	13–17
			Aver.	.....	.....	3–4	6–8	9–12	13–17	4–5.5	10–13
			Unfav.	.....	.....	2.5–3.0	5–6	7–9	10–13	3.5–4	7.5–10
17	21¾x21¾	440–500	Fav.	.....	.....	3.5–4.0	6–8	9–12	13–17	5–5.5	10–13
			Aver.	.....	.....	2.5–3.5	5–6	7–9	10–13	3.5–5	7.5–10
			Unfav.	.....	.....	2.0–2.5	4–5	6–7	9–10	3–3.5	6.5–7.5

TABLE VII. Design Data for Low, Medium, and High Mounting Reflectors

These data apply to low, medium, and high mounting reflectors designed for high interiors. As aluminum, chromium, silvered glass, prismatic glass, or Alzaked aluminum reflectors, have different reflection co-efficients, the results given below are average.

Distance from Underside of Reflector to Floor to Be Not Less than (Ft.)	Approx. Spacing (Ft.)	Area per Outlet (Sq. Ft.)	Conditions Factor	Average Foot-Candles							
				Mazda Lamps						Mercury Lamps	
				200 Watt	300 Watt	500 Watt	750 Watt	1000 Watt	1500 Watt	250 Watt	400 Watt
Low / Medium / High	8x8	60–70	Fav.	.....	.....	.....	.....	.....	.....	52–60	.....
			Aver.	.....	.....	.....	.....	.....	.....	43–50	.....
			Unfav.	.....	.....	.....	.....	.....	.....	32–38	.....
	9x9	75–85	Fav.	.....	.....	.....	.....	.....	.....	42–48	.....
			Aver.	.....	.....	.....	.....	.....	.....	35–40	.....
			Unfav.	.....	.....	.....	.....	.....	.....	27–30	.....
	10x10	95–110	Fav.	.....	.....	.....	.....	.....	.....	33–38	.....
			Aver.	.....	.....	.....	.....	.....	.....	27–32	.....
			Unfav.	.....	.....	.....	.....	.....	.....	20–24	.....
	11x11	115–130	Fav.	.....	.....	.....	.....	.....	.....	28–31	.....
			Aver.	.....	.....	.....	.....	.....	.....	23–26	.....
			Unfav.	.....	.....	.....	.....	.....	.....	17–20	.....
	12x12	140–160	Fav.	10–11	.....	.....	.....	.....	.....	23–26	.....
			Aver.	8–9	.....	.....	.....	.....	.....	19–22	.....
18 ft. to 25 ft.			Unfav.	6–7	.....	.....	.....	.....	.....	14–16	.....
	13x13	160–185	Fav.	9–10	.....	.....	.....	.....	.....	20–23	.....
			Aver.	7–8	.....	.....	.....	.....	.....	16–19	.....
			Unfav.	5–6	.....	.....	.....	.....	.....	12–14	.....
	14x14	185–210	Fav.	8–9	12–13.5	.....	.....	.....	.....	17–20	30–35
			Aver.	6–7	10–11	.....	.....	.....	.....	14–16	24–27
26 ft. to 35 ft.			Unfav.	5–5.5	8–9	.....	.....	.....	.....	12–14	18–21
	15x15	210–240	Fav.	7–8	11–12	.....	.....	.....	.....	15–17	26–30
			Aver.	5.5–6	9–10	.....	.....	.....	.....	12.5–14	21–24
			Unfav.	4.5–5	7–8	.....	.....	.....	.....	9.5–11	16–18
	16x16	240–270	Fav.	6–7	10–11	18–20	.....	.....	.....	13–15	24–26
			Aver.	5–5.5	8–9	14–18	.....	.....	.....	11–12.5	19–21
			Unfav.	4–4.5	6–7	11–14	.....	.....	.....	8.5–9.5	14–16
36 ft. to 50 ft.	17x17	270–300	Fav.	5.5–6	9–10	16–17.5	.....	.....	.....	12–13	21–24
			Aver.	4.5–5	7–8	12–16	.....	.....	.....	10–11	17–19
			Unfav.	3.5–4	5–6	10–12	.....	.....	.....	7.5–8.5	13–14
	18x18	300–340	Fav.	5–5.5	8–9	14–16	19.5–23	.....	.....	10–12	19–21
			Aver.	4–4.5	6–7	10–14	14.5–22	.....	.....	9–10	15–17
			Unfav.	3.0–3.5	5–5.5	9–10	13–17	.....	.....	6.5–7.5	11–13
	19x19	340–390	Fav.	4–5	7–8	11–14	17–21	25–30	39–47	9–10	16–19
			Aver.	3.5–4.0	5–7	9–11	14–17	20–25	31–39	8–9	13–15
			Unfav.	2.5–3.5	4–5	7–9	10–14	15–20	23–31	6–6.5	10–11
	20x20	390–440	Fav.	3.5–4.5	6–7	10–12	15–18	22–26	34–41	8.5–9	15–17
			Aver.	3.0–3.5	4.5–6.0	8–10	12–15	17.5–22.0	27–34	7–8	12–13.5
			Unfav.	2–3	3.5–4.5	6–8	9–12	13.0–17.5	20–27	5.5–6	9–10
	$21\frac{3}{4}$x$21\frac{3}{4}$	440–490	Fav.	3–4	5–6	9–11	13–16	19.5–23.0	30–37	.....	13.5–15
			Aver.	2.5–3.0	4–5	7.5–9.0	11–13	15.5–19.5	24–30	.....	11–12
			Unfav.	2.0–2.5	3–4	5.5–7.5	8–11	11.5–15.5	18–24	.....	8–9
	$22\frac{1}{2}$x$22\frac{1}{2}$	490–540	Fav.	.....	4.5–5.5	8.5–10.0	12.5–15.0	17.5–21.0	27–33	.....	12–14
			Aver.	.....	4.0–4.5	6.5–8.5	10.0–12.5	14.0–17.5	22–27	.....	10–11
			Unfav.	.....	2.5–4.0	5.0–6.5	7.5–10.0	10.5–14.0	16–22	.....	7.5–8.5
	24x24	540–590	Fav.	.....	4–5	7.5–9.0	11.0–13.5	16–19	25–30	.....	11–12
			Aver.	.....	3.5–4.0	6.0–7.5	9–11	13–16	20–25	.....	8.5–9.5
			Unfav.	.....	2.5–3.5	4.5–6.0	6.5–9.0	9.5–13.0	15–20	.....	6.5–7
	26x26	640–690	Fav.	.....	3.5–4.0	6.5–8.0	9.5–11.5	13.5–16.0	21–26	.....	9.5–10
			Aver.	.....	3.0–3.5	5.0–6.5	8.0–9.5	11.0–13.5	17–21	.....	7.5–8
			Unfav.	.....	2–3	4–5	6–8	8–11	12–17	.....	5.5–6
	28x28	740–790	Fav.	.....	.....	5.5–7.0	8.5–10.0	12–14	18–22	.....	8–9
			Aver.	.....	.....	4.5–5.5	6.5–8.5	9.5–12.0	14–18	.....	6.5–7
			Unfav.	.....	.....	3.5–4.5	5.0–6.5	7.0–9.5	11–14	.....	5–5.5
	30x30	890–940	Fav.	.....	.....	4.5–5.5	7–8	10.0–12	15.5–19.0	.....	7–7.5
			Aver.	.....	.....	4.0–4.5	5.5–7.0	8–10	12.5–15.5	.....	5.5–6
			Unfav.	.....	.....	3–4	4.0–5.5	6–8	9.5–12.5	.....	4–4.5
	32x32	990–1040	Fav.	.....	.....	4–5	6.0–7.5	8–11	14–17	.....	.....
			Aver.	.....	.....	3.5–4.0	5–6	7–9	11–14	.....	.....
			Unfav.	.....	.....	2.5–3.5	4–5	5–7	8.5–11.0	.....	.....
	34x34	1140–1190	Fav.	.....	.....	4.0–4.5	5.5–6.5	8.0–9.5	12.0–14.5	.....	.....
			Aver.	.....	.....	3–4	4.5–5.5	6–8	10–12	.....	.....
			Unfav.	.....	.....	2–3	3.0–4.5	4.5–6.0	7.5–10.0	.....	.....

TABLE VIII. Design Data for Combination Unit



These data apply to Mercury Mazda Combination Units equipped with white diffusing globes.

Distance from Underside of Reflector to Floor to Be Not Less than (Ft.)	Approximate Spacing (Ft.)	Area for Outlet (Sq. Ft.)	Conditions Factor	Average Foot-Candles		
				1-250 Watt Mercury 3-60 Watt Mazda	1-250 Watt Mercury 3-75 Watt Mazda	1-250 Watt Mercury 3-100 Watt Mazda
7½	7¾x7¾	55–65	Favorable	50–65	55–70	62–80
			Average	39–48	42–53	48–60
			Unfavorable	29–34	32–42	36–48
8½	8½x8½	65–75	Favorable	43–53	47–58	53–66
			Average	31–40	34–43	39–49
			Unfavorable	24–31	26–34	30–39
8½	9x9	75–85	Favorable	37–48	40–53	46–60
			Average	28–37	31–40	35–46
			Unfavorable	23–28	25–31	28–35
9	9½x9½	85–95	Favorable	33–43	36–47	41–53
			Average	24–35	26–38	30–43
			Unfavorable	19–24	21–26	24–30
9½	10x10	95–110	Favorable	30–40	34–44	38–50
			Average	23–31	25–34	28–39
			Unfavorable	19–23	21–25	24–28
10	11x11	110–125	Favorable	27–33	26–35	33–41
			Average	19–27	21–29	24–33
			Unfavorable	16–19	18–21	20–24
10½	11½x11½	125–145	Favorable	23–30	25–33	28–37
			Average	18–23	19–25	22–28
			Unfavorable	14–18	15–19	17–22
11½	12½x12½	145–170	Favorable	21–26	23–28	26–32
			Average	16–20	18–22	20–25
			Unfavorable	13–16	14–18	16–20
11½	13½x13½	170–200	Favorable	18–23	19–25	22–28
			Average	13–18	14–19	16–22
			Unfavorable	10–13	10–14	12–16
12½	14¾x14¾	200–230	Favorable	14.5–18.0	16–20	18–23
			Average	10.5–14.5	11.5–16	13–18
			Unfavorable	9–10.5	10–11.5	11–13
13	15½x15½	230–260	Favorable	13–17	14–18.5	16–21
			Average	10–13	11–14	12–16
			Unfavorable	8–10	9–11	10–12
13½	16¾x16¾	260–300	Favorable	11–14.5	12–16	14–18
			Average	9–11	10–12	11–14
			Unfavorable	7–9	7.5–10	8.5–11
14½	18x18	300–340	Favorable	10–11	11–12	12–14
			Average	8–10	9–11	10–12
			Unfavorable	6–7.5	6.5–8.5	7.5–9.5
15½	19x19	340–390	Favorable	9–10.5	10.0–11.5	11–13
			Average	7–9	7.5–10.0	8.5–11
			Unfavorable	5–6.5	5.5–7.0	6.5–8
16½	20½x20½	390–440	Favorable	8–10	9–11	10–12
			Average	6–7.5	6.5–8.5	7.5–9.5
			Unfavorable	5–6	5–6.5	6–7.5
17	21¾x21¾	440–500	Favorable	6–7.5	6.5–8.5	7.5–9.5
			Average	4.5–6	5–6.5	6–7.5
			Unfavorable	4.0–4.5	4.5–5	5–6

lighting equipment are appearance of the lighted room, direct and reflected glare, shadows, vertical illumination, and ease of cleaning and relamping.

3. Determining the Conditions Factor. A room must be appraised first from the standpoint of its general proportions, as outlined in Table IV. Note first of all the general proportions of the room, that is, whether its width is approximately equal to the ceiling height or whether it is two, three, or four times the ceiling height.

After noting the general proportions of the room, the second step in selecting the conditions factor is to determine whether color of walls and ceiling is light, medium, or dark.

Third and final step is to decide whether the air is clean or dusty, sooty or smoky. This is referred to as a maintenance condition because it has to do with the maintenance of the lighting units. There is no definite table or guide, except observation, to go by in evaluating this condition. It may be designated as either *Very Good* or *Fair.*

Having determined the room proportions, the classifications of light, medium, or dark for the color of the walls and ceiling, and *Very Good* or *Fair* for maintenance, the *Conditions Factor* can easily be determined. It is not a numerical factor, but one that is given in terms of *Favorable, Average,* and *Unfavorable.*

4. Determining Lamp Size, Spacing, and Mounting Height. First make sure that the reflectors will be properly located in the room, and will thus provide evenly distributed illumination. Allowable spacing between fixtures depends upon their mounting height, which is the distance from the floor to the bottom of the reflector. A good general rule is to make the spacing between luminaires approximately equal to the mounting height. In no case is the spacing to be more than 1½ times the mounting height. Otherwise an even distribution of light is not likely to be obtained.

Make the distance from the wall to the first outlet approximately one-half the distance between outlets. Mounting heights usually found in industrial interiors range from 9 to 12 feet.

SUSPEND UNITS FROM CONDUIT

Unless the ceiling is abnormally low, suspend the reflectors by conduit rather than from the usual drop cord. Drop cords permit the reflectors to swing, so that after a time the insulation wears through, which may cause a short or open circuit.

Where low ceilings are encountered, mount the reflectors directly on the outlet boxes.

Desirable mounting heights for various spacings and for different types of reflectors are given in Tables V, VI, VII, and VIII. For a given mounting height, the approximate spacing of the outlets is given in the adjacent column. Uniform illumination will not be obtained if these spacings are exceeded.

After the proper reflector has been selected, locate the mounting height in the first column of the corresponding table. The approximate spacing to use will be found in the adjacent column to the right. Make a plan drawing of the room to scale, and locate the outlets according to this spacing. The distance from the wall to the first outlet should be approximately equal to one-half the distance between outlets.

DON'T

1. Use lamps in reflectors designed for smaller lamps
2. Expose ordinary lamps to severe vibration or shocks
3. Use lamps rated at a higher voltage than the circuit
4. Keep a lamp in service after it becomes blackened

After the outlets have been located and the total number has been determined, the Area per Outlet is easily found by dividing the total floor area by the number of outlets.

Where the existing outlets are properly spaced, the calculations may begin at this point.

Find the figure just determined in the column *Area per Outlet.* In the next column, *Conditions Factor,* locate the factor previously determined (*Favorable, Average* or *Unfavorable*). To the right on this line will be found the column that contains the foot-candle intensity chosen for the installation, and at the head of this column the size of lamp required to produce this intensity.

These tables show the resultant illumination that different sizes of tungsten-filament and mercury lamps will produce for various areas.

Foot-candle values listed in the tables for the various sizes of lamps include an allowance for depreciation that depends upon the type of reflector and the conditions under which it is used. The intensity, therefore, represents average values obtained in actual service.

If mercury lamps are selected, the distortion of color must be considered. In many industrial interiors the color quality of the light given by these lamps is not objectionable, but where it is, the combination luminaire is recommended. It utilizes one mercury lamp and two or more tungsten lamps.

An alternative layout involves the use of a mixed installation of mercury lamps and tungsten lamps in a staggered arrangement.

To illustrate the use of these tables, let us design the lighting system for an industrial interior. Assume that this is an assembling plant, the plan and elevation of which are shown in Figure 1. Rough assembly work is done in the craneway, and polishing and burnishing in the other portion of the shop. The interior finish is dark and the walls have a large percentage of window area. Maintenance is fair.

First, the foot-candles required are found from Table III under *Assembly (rough)* to be 10 foot-candles, with 15 foot-candles for the polishing and burnishing operations.

Second, the type of reflector for the craneway is limited, since the mounting height in order to clear the crane is greater than 20 ft.; therefore, a high-mounting type reflector will be required.

In the polishing and burnishing shop, which has a lower ceiling, the RLM Dome or Glassteel Diffuser may be installed. Since the RLM Dome will be satisfactory for this application, it is decided to use it.

Third, the *Conditions Factor* may be determined by considering the craneway as a separate room whose width is approximately equal to the ceiling height, whereas the remaining area has a ceiling height less than the width of the room.

Referring to Table IV under direct lighting and alongside the proportions given at the bottom of the first column (*Width Approximately Equal to Ceiling Height*) color of walls and ceiling is checked *Dark.* Continuing across and under *Maintenance of Equipment —Fair,* the *Conditions Factor* is seen to be *Unfavorable.*

TO DETERMINE SIZE OF LAMPS

Fourth, the mounting height and spacing and size of lamps are determined by referring to Tables V to VIII. The RLM Dome reflector was selected previously for the lower portion of the plant, and the high-bay type for the craneway. Trace across horizontally in Table VII on the line for 20x20 spacing, *Conditions Factor Unfavorable,* to the resultant illumination desired for this craneway, namely, 9 to 12 foot-candles. Following directly upward to the head of the column shows that a 750-watt lamp will be required in each reflector.

For the area with the lower ceiling height the same procedure is repeated, using Table V. The spacing is approximately 10x10 ft. and, as before, the *Conditions Factor* is *Unfavorable.* Tracing to the right, the desired intensity of 13-16 foot-candles is reached in the column indicating that a 300-watt lamp will be required for each reflector.

The outlets are then spotted in as indicated in the plan, care being taken to make sure that their spacing does not exceed the mounting height.

CHAPTER SIX

Lighting Maintenance

PERFORMANCE of a lighting system should be watched at least as closely as that of any production equipment. Granted that the system is modern, it should be kept as near as possible to its original efficiency. The actual cost of lighting, or the return on the money it represents, is a direct factor of maintenance.

Whether the plant generates its own power or buys it, the voltage should remain constant at the socket. The inevitable drop of 2.5 volts or so may as a rule be counterbalanced by providing a slightly higher voltage at the distribution panel. Excessive voltage drop occurs because the runs are too long, the wire too small for the load, or power and lighting loads are taken from the same lines.

KEEP THE VOLTAGE UP

For economical operation incandescent lamps must be burned at rated voltage. To assure the greatest possible uniformity of voltage, compute wire sizes to allow not more than a 2-volt drop from the panel to the farthest outlet on any circuit. A voltage drop of 5 per cent in a line means a decrease of 15 per cent in the light output of the lamps. For lamps with mogul bases—300 watts and higher—do not use wire smaller than No. 12.

Smaller wire is permissible for lamps with a medium base, but it is not recommended.

Since the 400-watt mercury lamp is equipped with a mogul base, No. 12 wire may be used, provided the load does not exceed the current-carrying capacity of the wire and the voltage drop does not exceed good practice.

Mercury lamps have a starting current higher than their operating current, as shown in Table IX. Therefore, when designing the wire size, fusing, and switching, use the starting current rather than the operating current in computations.

Control of lighting systems is important. Daylight varies many times throughout the day, as clouds come and go, and this changing level of natural illumination is detrimental to seeing conditions. The foreman, or whoever is designated to turn the artificial lighting system on and off, cannot be expected to know the exact instant when this should be done. Automatic lighting control, by means of "electric eyes," or photoelectric relays, will remedy this situation.

This application of the photoelectric relay refers, of course, only to general lighting systems that illuminate large areas, and not to local lighting where high intensities may be required.

Removal of dirt is one of the most important factors in lighting maintenance. Loss of light from dirt and dust is a serious matter in a large installation. One installation, for example, gave an initial illumination of 13.4 foot-candles. At the end of four weeks accumulated dirt brought this level down to 11 foot-candles—a drop of 17.9 per cent.

Experience shows that bulbs and reflectors should be wiped free of dust at least once a month. Except in unusually dirty locations they should be washed at least once every 60 days. It is not a bad plan to alternate dry and wet cleaning.

Stubborn cases of encrusted, greasy dirt require warm water and soap or a mild grease solvent. Tri-sodium phosphate is a good wet cleaning agent. Extreme cases of hardened sooty deposits, particularly on outdoor equipment, may require application of a dilute solution of oxalic acid.

After washing with soap and water, rinse the reflector in ammonia water (a pint to a bucket); then wipe and dry thoroughly.

Cleaning costs vary, but seem to average about 4 per cent of the total operating costs of a lighting installation. If, as seems evident, such cleaning will increase the illumination 20 to 25 per cent, the results pay for the expenditure four or five times over.

Ease of accessibility of the lighting unit is important. In industrial installations, disconnecting hangers facilitate removal of both reflector and lamp to the floor for washing. This is much simpler and safer than cleaning fixtures on top of a ladder.

TABLE IX. Starting and Operating Current of Mercury Lamps

LAMP SIZE	STARTING CURRENT, AMP.				OPERATING CURRENT, AMP.	
	115-Volt Transformer		220-Volt Reactor			
	With P. F. Correction	Without P. F. Correction	With P. F. Correction	Without P. F. Correction	With P. F. Correction	Without P. F. Correction
400	...	...	4.0	5.5	2.5	3.5
	7.5	10	...	...	4.5	6.5
250	...	...	2.0*	4.0*	2.0	3.0
	4.5	7.5	...	...	3.5	6.0
85	...	3.0	* Must be operated with 220-volt transformer		...	2.0

TABLE X. Light Reflection from Typical Walls and Ceilings

Surface	Class	Color	Light Reflected Per Cent
Paint		White	81
Paint		Ivory	79
Paint	Light	Cream	74
Caen Stone		Cream	69
Paint		Buff	63
Paint		Light Green	63
Paint	Medium	Light Gray	58
Paint		Aluminum	50
Caen Stone		Gray	56
Paint		Tan	48
Paint		Dark Gray	26
Paint	Dark	Olive Green	17
Paint		Light Oak	32
Paint		Dark Oak	13
Paint		Mahogany	8
Cement		Natural	25
Brick		Red	13

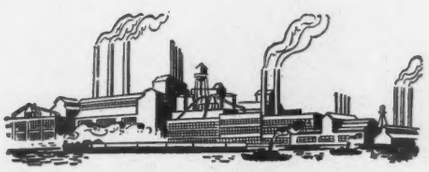
PAINT WALLS AND CEILINGS LIGHT

What has been said about dirt on reflectors applies in principle to grimy walls and ceilings. To reflect the maximum amount of light that strikes them, interior surfaces must be coated with light-colored paints. Paint and light are inter-dependent. Color of the surroundings has a marked influence on the resultant illumination, as well as a psychological effect upon employees. As shown in Table X, colors vary widely in ability to reflect light. Since, with any system of lighting, considerable light falls on the surrounding areas, it is only by making these areas as light as possible that the highest efficiency can be assured.

For ceilings, flat white paint is preferable. Glossy surfaces should be avoided because of their tendency to glare.

The secret of an efficient lighting installation, after proper installation, lies in planned, periodic attention. Frequent lightmeter surveys are recommended in order to detect depreciation. With the pocket-sized meters now available, a check-up from time to time may save many pairs of eyes, not to mention needless accidents and spoilage.

WASTE CONTROL



NINETEENTH IN THE SERIES OF

FACTORY MANAGEMENT and MAINTENANCE
PLANT OPERATION LIBRARY

Less Waste Means Greater Profits

AN OLD-TIME shoe manufacturer used to boast that the profits were made in the cutting room. He meant that one had to *buy* materials "right" in the first place and *use* them "right" in the second. Yet he spent most of his waking hours figuring out how and where he could save a penny or two in his labor costs, and left the conservation or waste of thousands of dollars' worth of upper leather entirely in the hands of a foreman and some forty cutters who neither lost a dime when they went over their allowances nor made one when they stayed under.

The old gentleman could get mildly steamed up when the head stenographer, who kept the key to the supplies closet, told him she thought some of the office people were using more lead pencils than they ought to. He would have a conniption fit when the lasters asked for more money. But it never occurred to him that far greater possibilities for saving lay right up there on the sixth floor of the factory where each of those forty shoe-cutters had to all intents and purposes been given a key to the leather storeroom and told to go help himself whenever the spirit moved.

POTENTIAL PROFITS

Industry in general is something like that. It gets easily steamed up over this, that, or the other thing, but continues to shut its eyes to the potential profits that lie in the proper use and conservation of materials.

Yet here unquestionably is a major source of savings that may almost be had for the taking, and often require little more than simple diversion from the junk heap or the sewer to the profit account.

Of course materials are not the only things industry wastes. It wastes labor. It wastes space. It wastes machinery and equipment. It wastes electricity, steam, air, water, coal, oil, gas, and heat. It wastes through illness and accidents. But whatever it wastes it wastes mainly because the men out on the firing line—the foremen—have not been brought to a proper realization of their responsibilities in the conservation of materials and equipment and services.

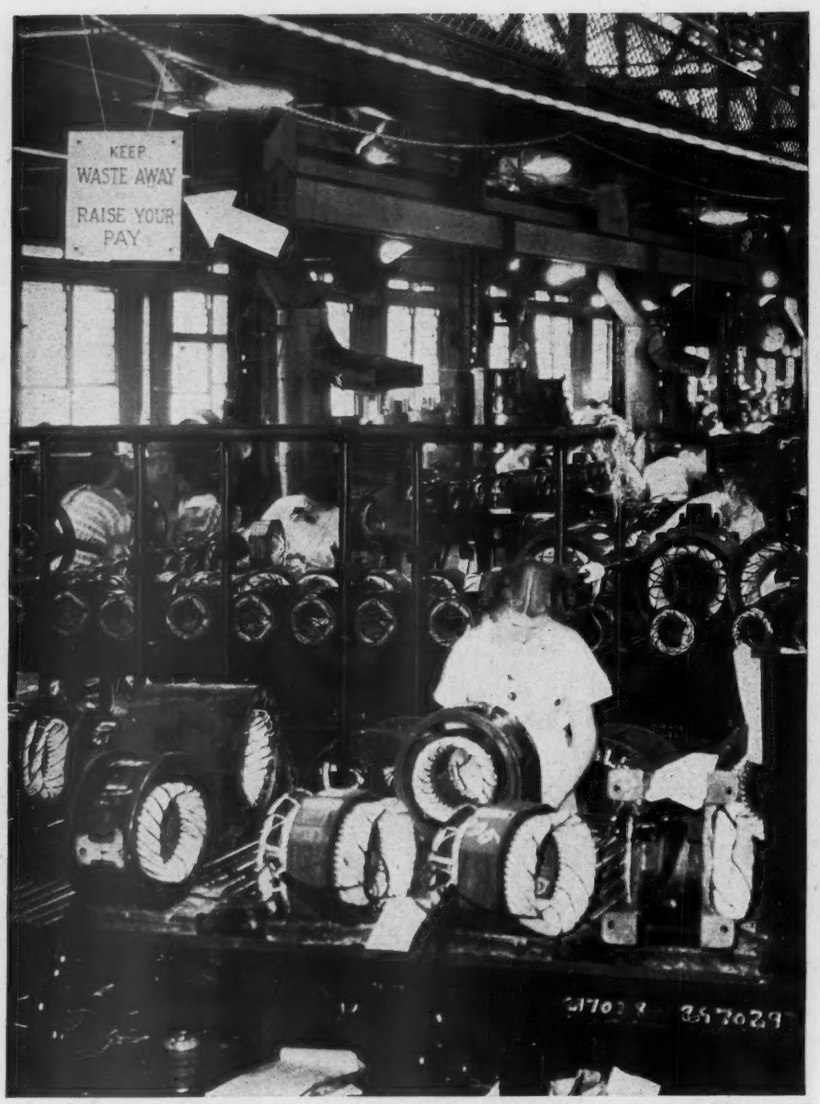
The basic way to drive home this sense of responsibility is through education. Some years ago The American Rolling Mill Company built an entire foreman training program around the elimination of waste. Twenty-four meetings were given over to group discussions of every phase of the subject. *Factory* published that program at the time in six installments. It remains to this day an outstanding example of how every foreman in the plant can be taught that waste prevention is an extremely important part of his job.

THREE CONTROL PLANS

Now *Factory* again, in the following pages, treats waste exhaustively. The approach differs, however, in that this time it has chosen to confine its attack to the waste of materials, and in so doing presents the waste control plans of three outstanding concerns instead of a single one.

From these three control plans the reader is free to pick and choose whatever he wants to use in his own plant. To facilitate the adaptation of any of the methods described, a number of useful forms have been reproduced.

Among the more thought-provoking methods described in this presentation of waste control is a budget plan that is tied in with foremen's bonus. Similarly stimulating will the reader find the page of photographs showing typical waste exhibits that have been set up for the edification of the foremen and workers of a fourth company. The man in the plant can seldom get above 75 cents in his conception of what a spoiled part or a spoiled tool costs. There is no better way to convince him of the high cost of waste than to confront him with the evidence.



Best way to get people out in the shop thinking about waste is to convince them of the close tie-up between waste elimination and pay envelopes. Westinghouse uses a slogan to keep that tie-up fresh in their minds

Budget Control Halves Waste Costs

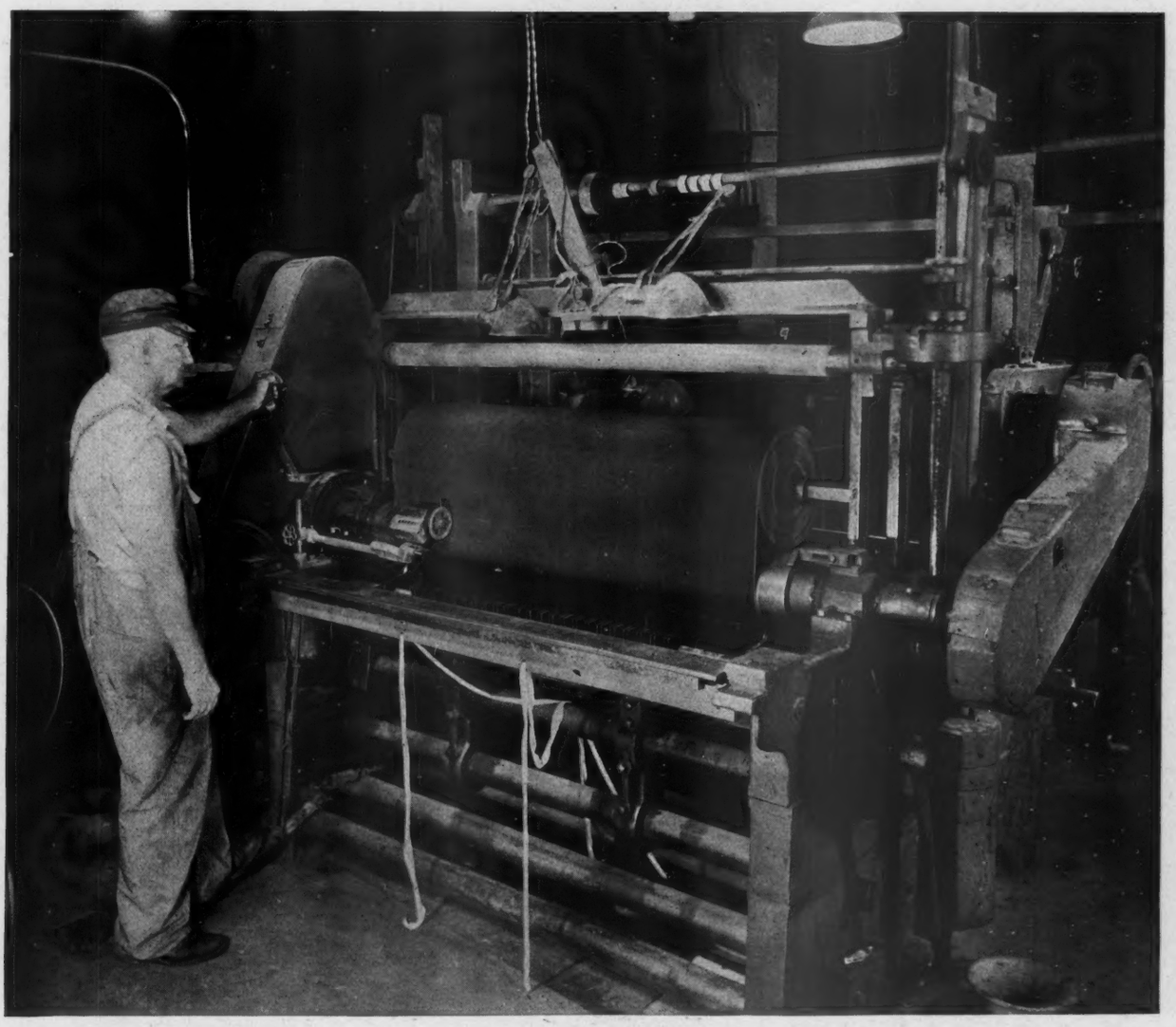
T. L. Lussen
Manager, Waste Control Department
Mechanical Goods Division
The B. F. Goodrich Company, Akron

WERE figures available showing the needless waste of materials that exists in industry, business might be shocked into making a more careful study of this problem. The reduced operating budgets and market prices of recent years have tended to create a greater interest in this subject, but it has yet to receive the same careful, scientific thought that is given to other production problems.

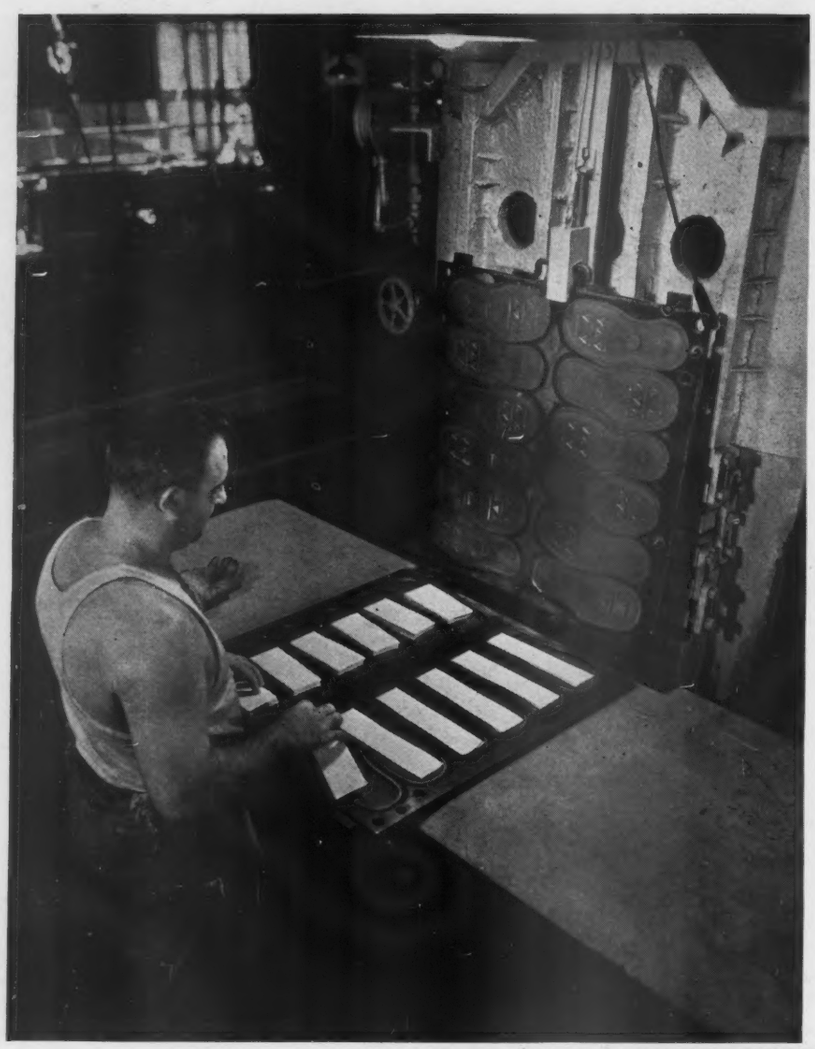
Several years ago the Mechanical Goods Division of The B. F. Goodrich Company recognized waste as a major problem. As a result, a Waste Control Department was organized in 1928 with a manager and three inspectors. The manager reports directly to the staff superintendent and is not responsible to the production superintendent. His duties consist of setting budgets on waste for the production departments, furnishing the cost department with waste figures for costs, bringing unsatisfactory waste conditions to light, and cooperating in their correction.

The three inspectors spend the greater part of their time in circulating throughout all departments, visually checking waste conditions and spot checking actual finished weights of production articles so that over-runs or other material wastes may be corrected.

Our basic plan for controlling waste is similar to the one that has been used so successfully in controlling other elements of factory cost—namely, budget control. In setting a proper budget for waste, the same difficulties are encountered as in setting all budgets, but we have the advantage of possessing



This splitting machine, originally designed to handle stocks up to 38 in. wide, was remodeled at a cost of $200 to accommodate stocks up to 44 inches. With this change, calendered width of stock was increased and resulted in savings on three separate items amounting to $2,000, $1,000, and $395 per year



By changing shape of preparation for rubber soles a reduction in cured trim or rind was made, amounting to savings of $5,000 a year. New shape is shown on right-hand side of mold; old, wasteful type at the left

complete waste records from the time of this department's organization.

From these records and our practical experience, we set up a yearly budget for each production department. This budget is set on a percentage basis of pounds of waste to pounds of production. The percentage of over-run or under-run is then applied to the actual dollars of waste developed each month. Budgets for new items of production are established only if their volume warrants and then not until we have had sufficient experience to enable us to arrive at a proper figure.

In some instances, as in the Molded Goods Division, we set budgets for each commodity. By commodity we mean items of a similar nature that develop similar waste percentages. For example, we have a commodity classification for tank bulbs in which we place production and waste on all tank bulbs regardless of size. In the Molded Goods Division we have 24 commodity groupings. This is necessary, for proper control, because of varying quantities of waste accruing per mold. Variation in waste may be attributed to construction of article, to material or compound used, or to method of preparation, and may run from 5 to 50 per cent of material.

One reason for segregating waste by commodity is, of course, that it enables us to maintain close control. Another reason is that it is easier to determine costs. With proper information available, an item developing a low waste, due to volume, shape, and construction, is not penalized with the high waste developed by some other.

Because of the costly nature of our materials, we have found that it pays to report waste in detail. Each production department, therefore, reports all waste each day on a special record form (See Figure 1). On this report is shown the pounds of each kind of waste developed daily by each commodity. This waste is reported either as "natural" or "defective" waste. We classify natural waste as waste natural or unavoidable in our manufacturing processes, such as skeleton scrap, cured trim from molded goods, uncured combination fabric and gum stock that cannot be reworked, and cured hose ends. We consider defective any article that does not meet our standard of quality.

Daily waste records are collected with production reports, and from them a daily record (Figure 2) is prepared

Figure 1. Each production department reports its waste daily, classifying it as "natural" or "defective"

DAILY WASTE RECORD

DEPT. NO. DATE 193

COMMODITY NO.	CODE	GUM	FABRIC	FRICTION	COAT	LB. NATURAL	LB. DEFECTIVE

Yellow-Card-Waste

	DAILY	ACCT. TO DATE	ACT. ACC.%	BUDGET%
Production				
Natural Waste				
Defective Waste				
D-O-Transfer				
Seconds or Remnants				
TOTAL				

REMARKS DEPT. 7040

for the three inspectors, showing percentage of waste to production. From this record the inspector is able to determine which departments or commodities in a department are running over the budget. He is then able to make a physical survey of actual production and waste in the department and locate the cause of the over-run.

The inspector works with the production foreman or supervisor. If he is unable, with the cooperation of the production organization, to reduce waste to the specified budget figures, the problem is handled through the general foreman or the production superintendent. We have found in our experience that this method of handling over-runs in waste is most effective and seldom fails to produce the desired results. There is also an added incentive for the production supervisors to lend every effort to keep commodities within the budget figure since the percentage of over-run or under-run is applied to the actual dollars of waste developed each month, and the result is tied in with our foreman's premium budget system. If their waste budget is overrun, they suffer a loss of premium.

Where we have an extremely rapid rise in production necessitating new and inexperienced employees and resulting in high waste, we have found it betters conditions to show the daily losses in waste in terms of dollars and cents. This report (see Figure 3) is made from the daily waste record and production reports. It shows standard or budget percentage of defective waste and actual percentage of defective waste. Factory cost of defective waste is shown in dollars and cents. This report serves two purposes—after being noted by the supervisor it is posted on the bulletin board for the attention of the workers. Not only is the supervisor informed of the excess cost of defective goods, but the value of the wasted material is also impressed upon the workers.

POSTING THE RESULTS

We also discovered in items of large production, developing excess waste, that it is decidedly worth while to classify waste and production by shifts. The posting of percentage of defective waste by shifts has developed a keen competitive spirit among the workers that has resulted in reduced waste.

Because inspectors make daily contacts with the various production departments they are in a position to make many valuable suggestions on the reduction of waste. For example, on one particular item the width of the stock being calendered was increased from 38 to 44 in., with a saving of $2,000 per year. To make this saving possible, it was necessary to spend only $200 on the slitting machine used to cut the stock. Two other stocks were later adapted to this machine with yearly savings of $1,000 and $395.

At the time one of our matting molds was in the shop having changes made, we were able to work out a reduction in size of the rind cavity which resulted in a saving of $500 per year. In one department where waste was supposedly at a minimum, we recommended that they try a slightly different shape of preparation. This was done with a reduction in cured trim or rind amounting to $5,000 a year.

Above suggestions were made after a careful study of both product and process. We have no faith in spasmodic waste campaigns and have based our plan on a steady drive for waste reduction throughout the entire year. Whether or not the cost of such specialized effort is justified can best be judged by the results obtained. In 1934 the records showed that waste cost per dollar of sales was exactly 50 per cent that of the 1928 figure. Despite this accomplishment, we in no way feel that we have exhausted all the possibilities for further waste reduction and anticipate lowering waste cost with each year's efforts.

DEPARTMENT 7500-DEFECTIVE WASTE REPORT

	DAILY			ACCUM. TO DATE				
	PROD.	DEF.	VALUE	PROD.	DEF.	ACC. %	BUDGET	LOSS
01- Balls								
02- Sweeper Belts								
03- Tank Bulbs								
04- Graphite Bushings								
05-31 Dresser Rings								
32- Diaphragms								
33- U.J. Disks								
34- Valve Disks								
35- Inflations								
36- Insulators								
37- Metal Motor Mts.								
38- Oil Well Specialties								
39- Multigraph Platens								
40- Fender Tread Plates								
41-42 Plumber Goods								
43- Respirators								
44- Wringer Rolls								
45- Springs and Slabs								
46- Stoppers and Corks								
47- Valves								
50-97 Miscellaneous								
75- Fisher Body Strips								
76- Misc. Auto Parts								
77- Toy Tires / Toy Wheels								
Total Dept.								

COM. NO. DEPT. NO.

DATE	PROD.	NAT. WASTE	%	DEF. WASTE	%	SECONDS	%	TOTAL	DATE	PROD.	NAT. WASTE	%	DEF. WASTE	%	SECONDS	%	TOTAL
	BUDGET																
1									16								
2									17								
3									18								
4									19								
5									20								
6									21								
7									22								
8									23								
9									24								
10									25								
11									26								
12									27								
13									28								
14									29								
15									30								
									31								

Figure 2. From the daily waste records a report showing percentage of waste production is made up for the three inspectors of the waste control department

Figure 3. This report shows daily losses in dollars and cents, indicates budget and actual percentages of "defective" waste

Show Them What They Waste

Waste exhibits confront Westinghouse employees with evidence of their "guilt," remind them constantly of the high cost of wasting materials

This Plan Helps Foremen Cut Down Scrap

J. D. Relyea
Superintendent of Manufacturing
Maxwells, Limited, St. Mary's, Ontario

AN INCONSPICUOUS 5 or 10 per cent waste figure on the cost sheet seems little in the abstract, but its translation into concrete fact in the shape of a pile of metal provides a staggering realization. An executive who wants to know need only examine the barrels of scrap that leave the plant or glance over the refuse dumps near the factory. He may also find that many mistakes are dissolved away in the acid tanks, or melted down in the cupola. Once started on an investigation, he will not be surprised to find that the reject bins in the assembly department are a general cesspool for errors made in parts manufacturing.

When the management is convinced that the matter of losses is worth looking into, the next step is to make supervisors "waste conscious." A concrete demonstration will give the knockout blow to uninformed complacency. This can be administered by accumulating one week's scrapped parts in some central depot and bringing all supervisors concerned to look the pile over.

NO PASSING THE BUCK

The handling of such meetings is of course influenced by plant policy, but experience has shown that the chairman should be a lesser executive than the plant manager, and the secretary should be neutral. The first few gatherings are bound to be lively ones, as the foremen are nervous of the new set-up, and feel that they are on trial. The presence of an understanding works manager helps toward a friendly trend and prevents a degeneration of the meeting into an entertaining but profitless game of passing the buck.

Preliminary progress with waste control meetings shows up the need for a means of charting and controlling spoilage. Inevitably the allocation of responsibility for losses becomes a burning question. The chief inspector's opinions are vigorously disputed, and the design engineering department is drawn into the fray.

An example of a commonly occurring episode, after a system of allocating waste charges has been set up, follows:

1. Foreman of finishing department protests at a charge made against him for an extra operation of tumbling small punch press parts. He claims the extra labor should be charged against assembly department, as it asked that the tumbling be done to remove a burr that interfered with the assembly of the product.

2. Inspector transfers charge to assembly department, but assembly foreman disclaims responsibility as the blanked-out parts came to him with burrs from punch press department.

3. Punch press foreman alibis himself, claiming that burrs were caused because the toolroom had ground so much off the die that the hole was down in the clearance of the die plate. Hence the hole is oversize to the punch and leaves a burr.

4. An attempt is made to charge the loss to the inspection department but

Figure 1. Key used to allocate responsibility for defects. From it the inspector makes up his "daily shrinkage report"

SHRINKAGE KEY
APPLIANCE ASSEMBLY DEPARTMENT NO. 17

ERROR NO.	NAME OF ERROR	CHARGE TO DEPT	ERROR NO	NAME OF ERROR	CHARGE TO DEPT.
X	Unlisted defects		14	Scratched or cut through nickel	17
1	Defective material	V	15	Dirty nickel	14
2	Nickel peeling	14	16	Defective element assembly	17
3	Bad polishing and buffing	27	17	Defective tapping	12
4	Bad blanking and forming	9	18	Oil spots or defective lacquer	14
5	Defective heater cord assembly	17	19	Split point	9
6	Ground	17	20	Faults due to eng. dept	2
7	High or low wattage	17	21	Defective weld	10
8	Split point	14	22	Defective nameplate stamping	17
9	Open circuit	17	23	Faulty inspection	23
10	Defective spinning	17	24	Broken in assembly	17
11	Defective riveting	17	25		
12	Defective tapping	19	26		
13	Defective parallel cord assem	17			

Figure 2. Daily shrinkage report used to record waste. Numbers correspond with those in key (Figure 1)

DAILY SHRINKAGE REPORT

DEPARTMENT NO._____ DATE_____

NOTE: Delete key letters not used KEY A-B-C

SYM. NO.	NAME OF PART	X	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	GROSS PROD.	NET PROD.	RE-JECTS	%	REMARKS
TOTALS																																	
DUE TO DEPT. NO.																																	

WEEKLY SHRINKAGE SUMMARY ALL DEPARTMENTS

REPORT NO. _____ WEEK ENDING _____

CHARGED FROM

CHARGED TO: DEPARTMENT	6	7	8	9	10	12	14	16	17	18	19	21	22	24	27	28	29	T.L.B.	SHRINKAGE THIS WEEK	SHRINKAGE LAST WEEK	SHRINKAGE % CHARGED TO THIS WEEK	SHRINKAGE % CHARGED TO LAST WEEK	DEPT.
Calrod 6	219																		219	27	8.	.58	6
Auto Press 7		208										70					444	160	882	864	.08	.08	7
Molding 8			14.72																1472	995	.40	.23	8
Heavy Press 9									6										6	—	.01	—	9
Sh. Metal 10								1											1	14	.01	.14	10
Light Press 12						930						783							1713	4552	.27	.71	12
Plating 14							65												65	76	.03	.06	14
Range Assm. 16								8											8	12	.08	.07	16
App. Assm. 17									29										29	33	.04	.06	17
Vit. Enam. 18										11									11	14	.10	.48	18
Machining 19																			—	—	—	—	19
W.D. Assm. 21												233							233	201	.33	.34	21
Box 22																			—	—	—	—	22
Japan 24												40							40	—	.59	—	24
Polishing 27															9				9	10	.03	.03	27
Motor Driven 28																			—	—	—	—	28
Fuse 29																	3109		3109	13686	.63	2.7	29
Vendors	4604								1001	16		179							5800	369			V
T.L. Base																							L.B.
Gross Shr. This Week	4823	208	1472	—	—	93																	
Gross Shr. Last Week	73	153	995	—	—	30																	
Gross Prod. This Week	2734	1,170,300	371,773	426,972	9,484	64																	
Gross Prod. Last Week	4662	1,038,160	431,494	392,945	9,970	44																	
Shr. % This Week	176.	.02	.40	—	—	.1																	
Shr. % Last Week	1.6	.01	.23	—	—	.1																	

SHEET METAL DEPT. NO. 10

YEAR	CARELESS $ LOSS	PROD. HR.	ACTUAL $ LPOH	% LOSS OR GAIN OVER PREVIOUS YR.		BUDGET	% O. OR U. BUDGET	
1929	838.25	-	-			-		
1930	313.14	25,883	0.0121			-		
1931	188.41	19,108	0.0099		18	0.0157		37
1932	140.40	14,779	0.0095		4.2	0.0089	6.7	
1933	123.07	17,937	0.0069		27.4	0.0089		22.5

Figure 3. Summary of the week's waste shows in which departments faults were found—to which departments they were charged

Figure 4. Actual results obtained in one department. Note drop from $838.25 in 1929 to $123.07 in 1933

inspector in punch press department proves that he checked and passed the part just before the die was ground. Toolroom foreman claims that the die has produced so many pieces he can do nothing with it, except make a new die plate.

5. On appeal to the management, responsibility for the loss is split between toolroom and inspection departments.

Cases like the above indicate the need, in any system of waste control, of providing means whereby waste can be charged to non-productive departments, and of including representatives of design engineering, inspection, and toolroom departments at the weekly meetings. The vital necessity of an unbiased allocation of waste losses becomes self-evident.

If the factory produces a large number of different parts, it becomes strikingly evident after a few meetings that a detailed organized system closely knit to the operating end must be set up if waste control is to be achieved.

A PLAN THAT WORKED

Many variations of set-up may be employed, each one perhaps adaptable to a different organization. Rather than discuss debatable pros and cons, I shall outline a plan that worked successfully in another plant with which I was connected, and which is similar to the waste control plan now being put into operation in our own plant.

A start was made as outlined above, and the following routine was made the nucleus of a planned waste control system:

1. Central scrap depot to which spoiled parts were sent daily.
2. Weekly attendance of all supervisors at scrap depot.
3. Appointment of one man with authority to place responsibility for losses.
4. Weekly discussion meeting including representatives of non-productive departments.
5. Issuance of minutes to all concerned promptly after each waste control meeting.

As the plan progressed, further means of control were set up and it was found that the services of the arbitrator were seldom needed except in a routine way. Supervisors readily signed for waste losses that were patently their responsibility.

In the beginning, depots for spoiled parts were established in each productive department. A ruling was made that all damaged parts were to be collected at these depots daily, and the departmental inspectors kept in touch to see that this was done. These inspectors kept a record of each day's spoiled parts on a daily shrinkage report. This report provided space for part numbers, part names, quantity produced, number of rejects, and reject percentage. The quantity of each rejected part was entered under a key number, each key number representing some particular defect as found by previous experience. A typical key sheet is shown in Figure 1. It was also found possible in most cases to indicate that an error under a particular key number was chargeable to a specified department, this notation of responsibility being made at the bottom of the form. A blank form of the daily shrinkage report is shown in Figure 2.

WEEKLY SUMMARIES

In preparation for the weekly discussion meeting, the figures from the daily shrinkage report were tabulated on a weekly shrinkage summary sheet. This form listed vertically all departments in the plant. Opposite the name of each department was recorded the

number of defects charged to the department. The department where these defects were found was indicated in a horizontal line at the top of the sheet. This summary sheet also showed the total number of defects for the current week and for the previous week, as well as the reject percentage of total production for both weeks.

The total number of defects charged against any department could be found by adding the columns horizontally. It was also found necessary to provide space in which rejects chargeable to defective raw material might be entered, under the heading of "Vendor." A typical weekly summary is shown in Figure 3.

ON COMPANY TIME

As a further incentive to waste consciousness, it was found that a good psychological effect was secured by hanging in each department a chart showing the week-to-week progress in spoilage reduction. The ordinates of the chart were the percentage loss of total production; the abscissas were the weekly periods.

Meetings were held after hours, and for 30 minutes after the factory stopped working supervisors were eating a meal furnished by the management in the plant cafeteria. It may be noted here that men on hourly rate were paid for the time spent at the meetings.

Starting with the lowest departmental number, the chairman opened discussion on each department's losses. Each foreman in turn was asked to explain the reason for the rejects and the loss percentage figure of his department. A brief summary of the discussion was entered in the minutes, and if a means of eliminating the defect was suggested by anyone present, it was entered as a recommendation in the minutes.

This entire procedure was based on the so-called "piece per cent loss." At that time the material efficiency of a department was judged by the number of pieces lost out of its production each week. Therefore the foreman's effort was to cause the line of percentage loss in his graphic chart to drop.

That there were some anomalies in this method was evident from the start. For instance, production could not be uniform, and if the particular week under consideration involved heavy production of a notably tricky part, the per cent loss was likely high for that period. Another undesirable feature was that a high percentage loss in some parts might not represent a fraction of the dollar loss incurred by a low percentage loss in a much more expensive part.

The "piece per cent loss" system, even if not strictly comparative from a mathematical standpoint, did yeoman service for some time, and a great drop in losses became noticeable in all departments.

A further extension of the system to a consideration of the dollar value of spoiled parts was later carried out and enabled the losses to be charted on a dollar basis.

WASTE TICKETS

The foundation of this later development was in a system of waste tickets. It was set up as an inflexible routine that, if any job was spoiled, the foreman was obliged to sign a waste ticket before he could obtain the necessary extra material to fill his production order. These tickets were strictly controlled by the inspection department. One copy of this waste ticket, showing the extra material used, was forwarded to the cost department, which compiled the cost of the wasted parts up to the particular operation concerned.

Operating from the cost figures obtained from these waste tickets, which had been in operation for some time, it was possible to set at the beginning of the year a dollar loss budget for each department. Budget objectives were based upon the number of departmental productive hours. During 1930, let us say, a department had a definite dollar loss and a definite number of productive hours. By dividing the dollar loss by the number of productive hours, it was possible to arrive at a decimal dollar figure, which represented the average dollar loss per operator hour for the year 1930.

BI-WEEKLY COMPARISONS

Therefore, at the beginning of 1931, it was possible to set budget loss objectives and to say to any foreman that he would be budgeted for the ensuing year on the basis of his previous year's performance. Perhaps his production hours would be low in January but his budget would be correspondingly low, and so on in direct ratio.

It was found best, in view of the way in which figures on productive hours were secured by the accounting department, to compare the actual losses with budget objectives on a bi-weekly basis.

Each foreman was given a sheet entitled "careless loss per operator hour budget." This sheet carried columns for the period date, the productive hours worked, the period objective loss, and the actual loss. Accumulative columns were also carried, and a further column for the percentage figure, objective and actual.

The figures on the budget dollar loss were considered at the same time as piece per cent loss and became a regular feature of the meetings. It was a simple matter to put up extra charts showing the trend of the dollar loss performance of departments.

Figure 4 shows actual results secured in one small department.

Any experience with such a system will soon show the necessity of changing it to suit the particular factory. The allocation of losses to non-manufacturing departments, the separation of losses into natural and careless, the prevention of covering up by careless foremen, the regulation of waste tickets, the responsibility of inspectors, are all controversial matters that can be settled by a determined, far-sighted management in a way that will imbue the whole factory staff with a spirit of cooperation.

Molds ready for pouring never tell how many scrapped parts will be melted down. Waste control goes behind the cupola for the answer

Manufacturing Losses —Cause and Cure

F. F. Wilkins
Planning Engineer, General Electric Company
Pittsfield, Mass.

PROFIT performs a most essential and useful function in industry. It is at one and the same time the alpha and omega of business activity. Desire for it is the force that fires the spirit of enterprise. Realization of it supplies the reward. It is this invisible current that motivates the whole machinery of our economic system. It is the instigator of new enterprises and the extender of old. No risks are too great for it, no obstacle is too big, no sacrifice too much. Curtail it and enterprise is curtailed; increase it and progressive business activity is stimulated; destroy it and the prime motive on which progress depends is destroyed. It is not, however, a fixed amount by any means but depends upon the field covered, the demand for the product, and last but not least the business acumen of the management.

PROFITS ARE SMALL

Although the annual business of the United States is about 80 billion dollars in good years the average profit on this business is small. True, the margin added to direct cost is large enough, but after the rent, wages, and all other expenses have been paid the net profit is an astonishingly small figure. A study of 93 companies of this country representing 24 of our major industries shows that the annual profit ranges from a maximum of 19 per cent to a minimum of 1.3 per cent with an average for the group of 7.2 per cent.*

The main problem facing every management is to find means of increasing profit. There are two general ways in which this may be done: First, by increasing the selling price; second, by reducing the cost. In an established field of business an increase of selling price would be practically impossible because of competition. The other way is to reduce costs.

Reduction in costs may be attacked from three different angles—labor, expense, and materials. We find that the average cost of a certain field of production is divided as follows: Labor 12 per cent, expense 40 per cent, and purchased material 48 per cent. However, we also find that the organization for controlling labor (12 per cent of cost) is approximately four times the size of the organization for the control of the other two items which comprise 88 per cent of the cost. Let us give our attention to the less developed field of material control with particular reference to waste and spoilage.

The 1930 statistics from the U. S. Department of Commerce show that the annual waste loss in industry is $10,000,000,000. In addition there is a spoilage loss of $4,000,000,000, making a total of $14,000,000,000 annual loss, equivalent to approximately three times industry's profit in 1929. It is estimated by the Department of Commerce that $500,000,000 of this loss alone could be saved by "simplified handling" and "the elimination of waste by supervision" would effect an annual saving of $1,750,000,000.

In the following discussion, some of the steps that are being taken to eliminate waste and spoilage will be pointed out, and a few examples of the savings realized will be given. The examples are drawn from the files of a number of companies and, although the general data and figures used are commensurate with the actual cases, they have been altered somewhat to protect the sources of information.

FIVE CLASSES OF WASTE

First let us consider waste. Waste we will define as the residue of material after all manufacturing processes have been completed. It appears at the scrap heap in the form of turnings, ends of stock, clippings, contaminated liquids and compounds, dross, small pieces of wire, solder, pressboard, etc. In other words the material itself is usually unchanged in composition, but the pieces are so small that they cannot be used in making a part.

Although the number of specific causes of waste is too large to tabulate here, they may be grouped into classes according to the fundamental causes in the order of their importance:

1. Design of product.
2. Carelessness and ignorance of values of material.
3. Improper planning.
4. Design of manufacturing and handling equipment.
5. Conditions of materials as purchased from the vendors.

Because the design of the product can exert an important influence on the amount of waste, all concerned with this activity should realize that the efficient use of materials and the elimination of waste are of prime importance in manufacture. They should be continually striving to reduce the amount of inactive or unnecessary materials in their products, and consequently to reduce the scrap or waste of active material in the product itself. They should bear in mind always that if a part is round, waste is much greater than if it is square. If it is an odd shape like the hands of a clock, waste is still greater. If the part is a fraction of an inch wider, it may require the use of the next standard size of material and so occasion more waste along the edges of the stock. A little forethought on the part of the designing engineer may save a great amount of waste.

INFLUENCE OF DESIGN

A case comes to mind of a steel collar for a shaft with a flange that more than doubled the waste on the part. This part was reviewed by screw machine and drop-forging experts but no solution was forthcoming. However, by checking the design of the unit in which this part was used it was discovered that the particular shape and size of the flange was not inflexible. The flange was changed and the price reduced from $0.12 to $0.04 each with an annual saving of $1,800.

Reduction of waste caused by design in apparatus already in manufacture can only be accomplished by a complete and critical review of the design itself in which attention is devoted almost entirely to the material requirements of each part. New machines, new materials, and new processes are continually being developed that will permit valuable savings in waste through alterations in design.

A review was made of the parts being made in a screw machine department, and when a part was found that had a high percentage of waste this waste was translated into annual dollars loss and a memorandum of the loss sent to the design engineer with a request for review of the design. This review resulted in changes in design of four parts effecting a saving of $4,530 a year.

Carelessness on the part of operators can be found in almost any plant because some may lack interest in the particular job to which they are assigned. There are two ways in which this carelessness may be overcome—by discipline and through the operator's natural pride in his own accomplishment. Of these two methods the latter is by far the more effective and practical method and requires the least expenditure of time and energy by the supervisor.

* U. S. Statistics of Income for the 10-year period, 1923-1933, show that the manufacturing industries averaged only 4.2 cents profit per dollar of sales.—Editor.

An example of the effectiveness of the above method is cited from one company in which there was an annual loss of $4,000 in materials or 2 per cent of the material input. Although the per cent of loss was small it was believed that it was greater than need be. A system was established whereby each operator's waste was weighed daily and the weight written on a chart for the purpose, displayed prominently in the workroom. The change was apparent in one week. The total was cut in half, and at the end of the year the waste was found to have averaged 1 per cent—which meant a saving of $2,000 annually.

NEED TO EDUCATE

Ignorance of values of materials will be found to exist in any department where steps have not been taken to educate the employees along these lines. In many cases this condition causes excess waste loss because the operator does not realize how many dollars are involved in the small bits of material thrown away, and he may discard two to three times as much as is necessary. Education of operators to material values is a simple matter which takes little time and brings valuable results. Both a chart showing values of materials in departments where many materials are used and a little propaganda among the operators are effective.

An example of the value and effectiveness of such a scheme is drawn from a company in which the operators were working upon specially processed aluminum, and the waste averaged 15 per cent or about $50 a day. The material appeared to be light. The operators did not realize how much they were wasting until it was called to their attention that the material was worth $1 a pound. Educating the operators effected an immediate reduction of 7 per cent in the waste, or an annual saving of $8,000.

Another important cause of waste is the lack of proper planning. If the selection of the right sizes of material is left to men on the factory floor who are under pressure to get out production, it is reasonable to expect that they will not always use the best of judgment. An employee whose job it is to do this material planning can do it much better and keep in mind the fundamentals of efficient utilization.

Take for example sheet steel widths in a punch press department. The steel used for punchings was carried in 13 widths varying from 27 to 40 inches. The majority of the punchings cut were from strips varying from 12 to 19 inches. The problem of the selection of proper combinations of strips to be sheared from full-size stock was an important one in material utilization.

Formerly it was the practice to make this selection in the factory. As a result inefficient combinations were used in order to get out two punchings needed in a hurry, or strips were piled on the floor which were difficult to use efficiently because the shop men could not have a broad picture of the total production required for the month. They did not have the information for proper planning.

When a careful study of waste was made in this department, the routine was changed. Width of steel required for every punching and number of punchings from a sheet were indexed in the production department. When the following month's schedule of punchings was prepared, it was one of the duties of the order man to determine the shearing combinations to balance the production in order that the material might be used to the best advantage. When an order was placed in the factory, it designated not only the number of punchings to cut but the number of stock sheets to shear, the width of the stock sheet to be used, and for what the remnants were to be used.

Under the old system it was not uncommon to waste ½ to 1 in. on the side of a strip of steel worth 7c a pound. At present a monthly schedule is laid out with no waste on the punchings having the largest production, and not more than ⅛ in. on other strips. Side loss was reduced from 1.61 to 0.94 per cent, effecting a saving of $4,250 a year.

Design of manufacturing equipment is an important factor in waste control. Tools may be designed without much thought as to minimizing waste, and end and side allowances may be much more than the occasion requires. To correct this, a careful study must be made of each piece manufactured to ascertain the proper size of blank and to make sure that no other part can be punched from the scrap. Frequently it was found possible to utilize the waste skeleton for smaller parts. This may require special tools so that both parts will be punched at the same time. Another way to avoid waste is to use wider material and nest the pieces where a peculiar shape is demanded.

One manufacturer has gone so far as to set up a separate department where all remnants are delivered. In this department are eight or ten punch presses where operators punch out small parts such as washers and other standard pieces. The firm even solicits orders for small parts that they can produce from their stock remnants. In this way an otherwise total loss is converted into a profit, and the department has paid for itself many times over.

SURPRISING FIGURES

In the design of tools for manufacturing operations there is often a wider end and side allowance than is necessary for facility and accuracy of operation or even a larger cut-off tool or saw is used than the occasion demands. A small, almost negligible loss it would seem, but when thousands or millions of pieces are made the loss in excess waste amounts in a year to surprising figures.

Take for example a small insert once used in the manufacture of a door lock. The insert was made from 3/16-in. round brass rod and the standard cut-off could be reduced from 0.045 in. to about 0.028 in. on this particular job, making a saving of 0.017 in. a piece. This difference was scarcely perceptible and yet when figured on the basis of the annual production of 100,000,000 a year the saving was $1,910.

Another source of loss is in the material received from vendors. To a large extent trade practice governs the condition of the material as it is received. Steel plate, for example, may not be flat; sheet steel may not be straight edged; bar stock may be in lengths shorter than specified. Commercial grades of material have definite specifications, and an offending vendor should be quickly taken to task if the imperfect material exceeds the allowance.

On one class of brass rod used in a screw parts company, the vendor guaranteed that not more than 10 per cent of the material would be in short lengths. After six months' operation an investigation showed that over 40 per cent of the material was received

Many a plant that spends considerably more for materials than for wages has a big, expensive set-up for the control of labor costs, none at all for the elimination of waste. The same attention devoted to the conservation of materials might easily yield larger returns—and welcome additions to the profit account

in short lengths. The vendor was taken to task and held to the guarantee, and an extra loss of $500 a year was stopped.

Spoilage is defined as the material and labor lost on the parts or units rejected because they are not according to specifications or dimensions. It appears on the scrap heap in the form of parts apparently perfect, yet when scrutinized closely they will be found to have a hole drilled 1/32 in. too large, a stripped thread, a small crack, etc.

As with waste the spoilage is occasioned by many varied causes, yet they may all be separated into basic classes as follows:

1. Engineering and drafting error.
2. Defective workmanship.
3. Damaged in handling.
4. Defective materials purchased.
5. Surplus and obsolete materials.

There is always present the possibility of outright errors in engineering and drafting judgment. The first design appears entirely practicable on the drafting board, but when the apparatus is manufactured and tested it becomes obvious that some part must be changed to produce a satisfactory product. In such a case the loss in replacing or revamping the redesigned parts must be treated as spoilage.

HIGH COST OF SPOILAGE

In one instance the designer of a large piece of machinery made a small mistake in material at a very vital point. When tested, the machine failed, and the repair cost the company $5,000 in new parts and labor.

In another company a machine was designed for a specific service and tests upon the finished product were satisfactory, yet when it had been in service a short time, it failed because of conditions unforeseen by the design department. Thousands of machines had to be replaced by a new design at a $500,000 loss to the concern.

The manufacturing organization generally bears the brunt of the blame for spoiled work. Too much haste or too deep a cut may ruin an expensive shaft. A bolt improperly tightened may cause a finished piece of apparatus to be wrecked. A semi-automatic machine improperly adjusted or operated may spoil hundreds of pieces before corrections are made. Hundreds of examples might be cited offhand which pile up losses that can be kept at a minimum only by close supervision and the fixing of responsibility.

When workmanship is defective, it is necessary to allocate the rejects to the operators at fault and apply corrective measures. If an individual is unsuited for the work to which he is assigned, a change of occupation may bring out latent possibilities. The efficiency of control depends to a large degree upon the ability and interest of the supervisor, his knowledge of human nature and its limitations.

A serious loss in final test in a certain section was thought to be partly due to a certain amount of carelessness on the part of operators, but it was also realized that a large part was due to defects in materials which could not be eliminated. It was hard to differentiate between failure due to operator and that due to defective material. A plan was devised in which the operators marked all the parts made by them and the rejects were carefully examined for cause. It was difficult at first to fix responsibility but after a few weeks the inspector became very proficient and the operators were shown evidence of their negligence. Each week a list was posted in a conspicuous place showing names of operators, number of parts defective, and loss due to negligence of each operator. Annual loss in this section was reduced from $35,000 to $10,000, a saving of $25,000 after the inspector's time was paid for.

DAMAGED IN HANDLING

From the moment that material is delivered to the manufacturing plant until it leaves as a finished product it is being continually handled by operators, stored, carried by conveyors and trucked from one department to another. It is reasonable to expect that during all this handling a certain percentage is bound to be dented, cracked, or otherwise damaged unless special precautions are taken.

Transportation of certain porcelains, for instance, was done by truck with the pieces packed loosely in a tray. The breakage amounted to 2 per cent. To prevent this breakage, the parts were packed in the same trays but with corrugated paper spacers between them, and a $350 annual saving was effected.

Another case comes to mind of a small gear box about 3 in. in diameter with a ¼-in. shaft 12 in. long protruding from it. When assembled, they were packed carefully in trays and trucked to a storeroom from which they were drawn when needed, but when withdrawn they frequently had the shafts bent so that they were useless. An investigation showed that in the storeroom space was inadequate and trays were piled one on top of another in such a way that some of the shafts were bent, unknown to the storekeeper. It was finally necessary to have special trays made in which small slots were available to protect the shafts from bending. An expenditure of $50 for trays effected a $500 annual saving in material and additional labor.

Some spoilage results from defective materials purchased. If the defective parts cause a large loss, they may be returned to the vendor for credit; if the loss is small, it may be cheaper to take it than to incur the expense of records, accounting, and correspondence required to return them. If a small loss recurs frequently on some part, it may be well to accumulate the groups until the amount collected warrants the expense of a complaint.

Steel cases for the manufacture of a certain unit were purchased from another concern and at times cases were found that could not be used because of poor forming, insufficient solder on seams, bent and damaged sides and edges, etc. These were collected according to defect and returned to the vendor for credit. At times it was even necessary to have a representative from the vendor call to inspect the cans as received. This saved the concern $1,000 annually.

A large amount of loss is incurred in surplus and obsolete materials. A production section in building ten special machines may order surplus parts for two in order to insure against a delay in case of spoilage. If, however, the ten are built without mishap, there being no likelihood of more orders for this type, the extra parts cannot be used elsewhere and are scrapped. Standardization of product is the only way this may be overcome.

In initiating a new design to replace an old one, there is danger that old parts which cannot be used on the new design may be accumulated, become obsolete, and have to be scrapped. This condition may be overcome in many cases by balancing the stock on the old design and using it up before beginning on the new design.

LOSS MUST NOT BE TOLERATED

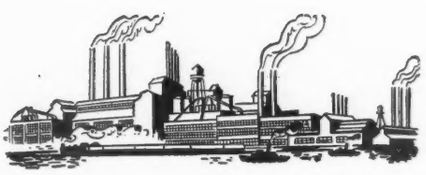
The greatest foes of loss elimination are ignorance, complacency, and contentment with things as they are. For elimination of manufacturing losses there are four essentials—mental attitude, facts, realization of conditions, and action. The most important is mental attitude, an attitude that will not tolerate loss. This must be fortified with thorough and complete knowledge of the losses as to quantities, kinds, sources, causes, and the best methods of elimination. Realization of conditions and action follow in quick succession.

The recent business depression was a time when all managements should have been investigating the possibilities in waste and spoilage reduction. Then, when it was so hard to make ends meet, when every dollar counted and all economies should have been effected, most industries broke up the organizations they once had for the reduction and control of losses in order to reduce expense. What folly to stop a remunerative avocation simply because one's income from one's vocation has been reduced!

It is extremely important to effect reductions in losses, since the one important result desired by management is to increase the amount available as profits, and this is most easily done by eliminating waste and spoilage.

Mechanical Power Transmission

AUTHOR
G. A. VAN BRUNT
Associate Editor



TWENTIETH IN THE SERIES OF
FACTORY MANAGEMENT and MAINTENANCE
PLANT OPERATION LIBRARY

CHAPTER ONE

Group and Individual Systems

METHODS of driving machines fall into two general classes: (1) Group drives, wherein several machines are driven by one prime mover from a common lineshaft; (2) individual or unit drives, in which each machine is driven by its own motor. Each of these systems has certain inherent differences and advantages.

It is a mistake to try to select the

Antifriction bearings (ball, on this lineshaft installation) help to reduce power and maintenance costs

type of drive that is most suitable for an entire plant. Study and decisions should be based on the conditions and requirements of each department, or even groups of machines. Conditions in different departments often vary so widely that blanket decisions are meaningless.

The following considerations are important in determining where group and individual drives should be used:

1. *Physical obstructions in the area to be served.* Overhead cranes, conveyors, or chains, and other obstructions may interfere seriously with ceiling-mounted, group-driving equipment. In such cases it is necessary to use individual drives, or mount group-drive lineshafts on the floor or on the ceiling of the floor below.

2. *Concentration of machines in the area.* A large number of machines in a comparatively small area usually lend themselves well to group driving. When machines are widely scattered, individual drive is preferable.

3. *Power required by the individual machines.* When machines require, say, 20 hp. or more and impose a fairly steady load they are usually, not always, best driven individually. If they constitute a highly intermittent load with occasional very high peaks, it may be advisable to combine them in groups.

When machines require up to a few horsepower, and particularly when their loads vary widely, group driving is preferable. When any machine is driven by its own motor, the latter must be large enough to handle the heaviest load likely to be imposed. Normally the load will be considerably less than the peak value, so that the machine is considerably overmotored. This condition results in low power factor and poor electrical efficiency.

4. *Frequency of changes in machine layout.* When machine location is changed frequently, individual drive usually has definite advantages in the cost and ease of making such changes over group drives requiring countershafts. With machines that do not require a countershaft the cost of changing location may be no more than the cost of moving individually driven machines.

5. *Variations in speed.* Requirements for speed variation may or may not definitely indicate one or the other type of drive. With group drives variable-speed transmissions can be used if countershafts do not meet all requirements. These variable-speed devices may be arranged for manual, remote, or automatic control.

6. *Effect of delays on production schedules.* Some trouble with power transmission devices is inevitable, but it is difficult to evaluate its probable effect. Much depends on the manufacturing set-up.

Motors in the sizes used for group drives are rugged and long-lived. Commonly mounted overhead, they are not exposed to water, oil, and other harmful agents. When properly selected for the duty they are usually not subjected to serious overloads.

Changes in power requirements of individual machines due to improvements in methods or product tend to offset each other on the different machines in a group. On the whole, increased power demand of some machines in a group is frequently balanced by a decrease on others, or by the elimination of some operation.

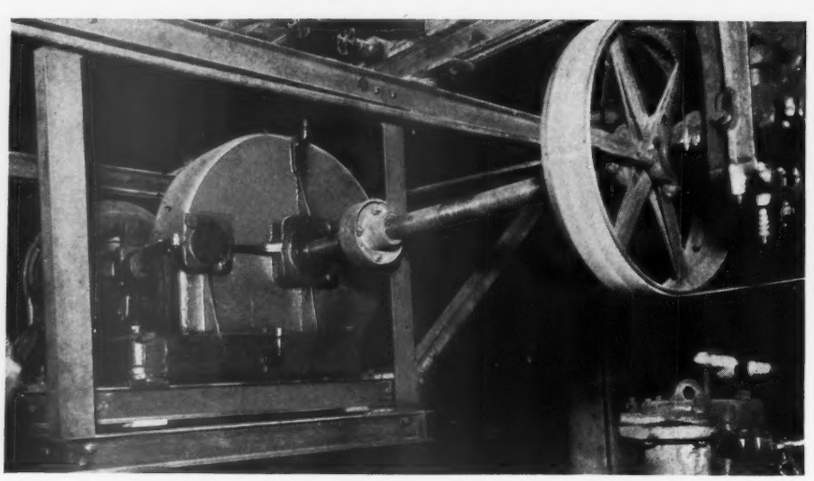
With ten to twenty or more machines in a group, cyclic variations in the power demands of the individual machines largely cancel out. The larger the group, the more complete is this balancing of the load. These conditions favor trouble-free operation.

HOW FAILURES AFFECT PRODUCTION

Small motors, on the other hand, are naturally less rugged. On individually driven machines they are frequently mounted close to the floor or are exposed to oil, cutting compound, iron dust, or other harmful agents. Load fluctuations and overloads are more severe. Motors driving individual machines lack the protection against extreme load fluctuations afforded by the diversity inherent in a group of several machines. Hence the number of failures per 100 motors in operation will be decidedly greater.

When a group-drive motor fails all of the machines in the group are shut down until the motor can be repaired or replaced. If this group of machines is making parts that go into stock before assembly, the delay will probably not affect production schedules seriously. However, if parts go indirectly from machines to assembly, a delay of more than a few minutes is likely to disrupt all schedules.

With individual drive, failure of the motor on one machine will have little



One of the lineshafts in a large automobile plant is driven by a 25-hp., 1,200-r.p.m. motor through a herringbone gear reduction unit. Lineshaft speed is 240 revolutions per minute

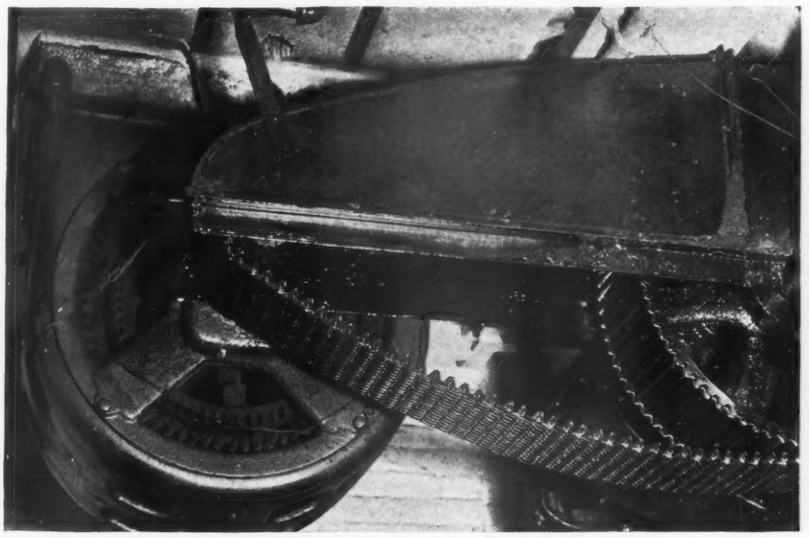
effect on production if a number of machines are making the same part, or if sufficient stock is carried to tide over an emergency. If the motor fails on the only machine that produces an important part, the delay may be very serious.

Consideration of these factors may disclose no compelling reason why one type of drive should be chosen in preference to the other. The advantages and disadvantages of one about offset those of the other. Choice between the two must then be made on the basis of such considerations as the comparative first and operating costs. These costs will vary for both group and individual drives according to the industry.

INITIAL AND ANNUAL COSTS

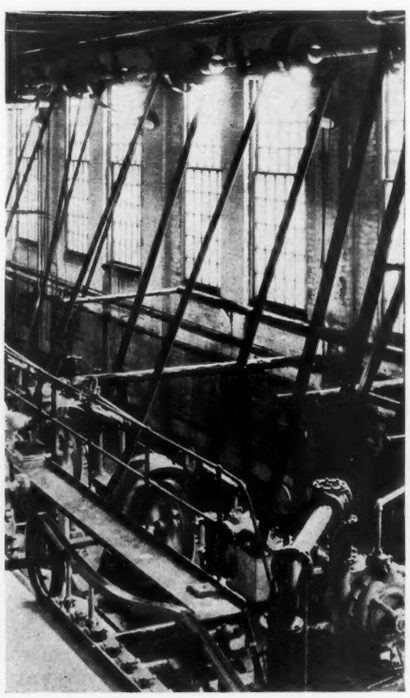
In the average manufacturing plant the first cost of all power transmission equipment, including electrical and mechanical items, will be almost twice as great for individual as for group drive. Specifically, the cost will be about 80 per cent more when the average size of the individual motors is 5 hp. or thereabouts. If the average size is 1 or 2 hp., the excess cost will be close to 95 per cent.

The total annual costs for individual drive will be about one-third higher than for group drive, somewhat more if the individual motor size averages only 1 or 2 horsepower.



A paint manufacturer prefers to use a silent chain drive between motor and lineshaft. It's rated 40 hp. The bottom of the chain's oil-retaining casing has been removed so that this photograph could be taken

These 8-in. rubber belts in a wood pulp mill are subjected to high humidity and temperature variations from 60 to 120 degrees Fahrenheit



For the type of plant that works night and day in some departments while it has no orders in others, and shuts down entirely in the dull season or during a depression, the first cost of the electrical and mechanical power transmission equipment will be from 2 to 2.2 times as great for individual drive as for group. The larger figure applies when the motors are small, say 1 to 2 hp. The lower figure holds true when the motors average 4 to 10 horsepower.

These cost relationships, as well as the inherent advantages and disadvantages of the two types of drive may, however, be seriously disturbed through failure to lay the drives out properly.

When laying out group drives it is important to avoid the mistake of making the groups either too large or too small. As a rule, groups driving from eight to twenty machines will give the best results. The optimum number of machines in a group will depend on the length of lineshaft required and the power taken by each machine.

CHAPTER TWO

Laying Out Group Drives

ARRANGEMENT of lineshaft groups varies with conditions. For example, some installations consist of the motor, a headshaft, a jackshaft, the lineshaft, and a countershaft. In many instances both the headshafts and jackshafts are omitted, and the motor is connected directly to the lineshaft. Likewise, countershafts are often omitted and the machines driven directly from the lineshaft.

Shafting employed in group drives is usually cold-drawn, low-carbon steel in the smaller sizes, hot-rolled in the larger. Alloy steel shafts are also used.

Determination of shaft size, depends on such factors as amount of power transmitted, speed of shaft, nature of load (steady, pulsating, or shock), number and size of pulleys, sprockets, or gears, type and location of bearings, and so on.

Headshafts reduce the speed between motor and lineshafts or jackshafts and must have ample load capacity. They are usually supported on two bearings. For size required when the headshaft is subjected to heavy stresses, use these formulas:

$Hp = (D^3 \times R) \div 125$, and

$D = \sqrt[3]{(125 \times Hp)} \div R$, where

$Hp.$ = horsepower to be transmitted

D = diameter of shaft

R = revolutions per minute

On ordinary installations the constant 110, instead of 125, should be used.

For long lineshafts (75 to 100 ft.) that are heavily loaded, use the constant 100 in the formulas above. When lineshafts are 50 to 75 ft. long and carry medium loads, with bearings spaced on 8-ft. centers, use a constant of 90. For short shafts (20 to 50 ft.) lightly loaded and with bearings spaced on 6-ft. centers, use a constant of 75.

In calculating the size of countershaft for average service and loading, a constant of 80 is used.

Line-, jack-, and countershafting is commonly suspended from the ceiling

Table I. Recommended Sizes of Motor Pulleys *

Hp.	MOTOR R. p. m.	PULLEY Diam., In.	BELT Width, In.	Hp.	MOTOR R. p. m.	PULLEY Diam., In.	BELT Width, In.
1½	1,800	4½	3	15	1,800	7	6
	1,200	4½	3		1,200	8	7
	900	4½	3		900	10	7
	720	5½	4		720	10	8
	600	5½	4		600	10	9
2	1,800	4½	3	20	1,800	8	7
	1,200	4½	3		1,200	10	7
	900	4½	4		900	10	8
	720	5½	4		720	12	10
	600	5½	4		600	12	10
3	1,800	4½	3	25	1,800	9	7
	1,200	4½	4		1,200	10	8
	900	5½	4		900	11	9
	720	5½	4		720	12	11
	600	7	5		600	13	12
5	1,800	4½	4	30	1,800	10	7
	1,200	5½	4		1,200	10	9
	900	7	5		900	12	10
	720	8	6		720	13	12
	600	9	7		600	14	14
7½	1,800	5½	4	40	1,800	10	8
	1,200	7	5		1,200	12	10
	900	8	6		900	13	12
	720	8	7		720	14	14
	600	9	7		600	16	14
10	1,800	7	5	50	1,200	13	12
	1,200	8	6		900	14	14
	900	8	7		720	16	14
	720	10	7		600	16	16
	600	10	8				

* Dodge Manufacturing Corporation

or roof trusses in drop hangers, or supported on walls or columns on wall brackets. In addition, head- and lineshafts often rest in pillow blocks supported on concrete piers.

Drop hangers and wall brackets are available in cast iron and pressed steel types fitted with plain or antifriction bearings. Some are arranged for automatic lateral adjustment, through the use of a ball-and-socket feature. Vertical adjustment is made by screws at the top and bottom. Other types are not self-adjusting, but provision is made for vertical and sidewise adjustment by screws.

Pillow blocks are likewise available in different constructions to meet different conditions.

KEEP LINESHAFTS ALIGNED

Several different constructions involving the use of timber or steel supports are used for mounting lineshaft hangers. For example, stringers may be bolted to building girders and the hanger bolted in turn to foot timbers. In steel frame buildings the usual practice is to bolt channel-iron stringers to the girders. Hangers are then bolted to channels fastened to these stringers.

Whatever method of mounting hangers is best adapted to the conditions, it is important to provide adequate rigid support for the lineshaft. As a rule, lineshaft hangers and other supports should be spaced on about 8-ft. centers. However, to avoid distortion of the shaft a bearing should be placed close to each large pulley or sprocket.

Finally, shafts must be kept properly aligned. Settlement of foundations, heavy loading of the floor above, and various other conditions tend to disturb alignment over a period of time. It should therefore be checked at sufficiently frequent intervals to insure its accuracy.

Bearings are a highly important element of power transmission equipment, and their selection warrants careful consideration. Sleeve or plain bearings are moderate in cost and are widely used on shafting. They are available in several designs having different provisions for lubrication—for example, ring or collar, and capillary oiling.

Antifriction bearings are of two general classes, ball and roller, of which the latter are made in several types, such as the flexible roller, tapered roller, and needle roller. Flexible roller bearings are split, to simplify installation, a feature that is not found in ball bearings, and other types of roller bearings.

These types of bearings are more costly, but when properly applied and cared for their use results in several definite advantages among which are reduction in power losses and little maintenance attention.

Shaft pulleys for flat belt drives come in five different types: Cast iron, pressed steel, wood rim with cast-iron center, all wood, and compressed paper rim with metal hub. Various designs of each type are on the market. Selection of the type most suitable for a given installation depends on frictional value of the surface, weight, ability to resist shock and carry overloads, resistance to steam, moisture, and acid fumes, flywheel effect required, method of fastening required (keying or clamping), and so on.

FIT THE PULLEY TO THE SERVICE

Cast-iron, pressed-steel, and wood pulleys can be obtained in light- and heavy-duty types in practically any size, capacity, and speed required. The cast-iron pulley will stand very severe conditions of driving, although it is sensitive to shocks and falls, and resists moisture, steam, and acid fumes. Pulleys with split hub, or split rim and hub, are easier to install and remove than the solid design.

Pressed-steel pulleys are made in several different designs. They combine great strength with light weight, will resist widely fluctuating or shock loads, and are considerably lighter and cheaper than the cast-iron type, although they are inferior in their ability to withstand steam and moisture, and will corrode under the influence of acid fumes or drip.

All-wood pulleys are light in weight and under ordinary conditions will perform as well as any metal pulley. They are cheaper than cast-iron or steel pulleys, have a higher coefficient of friction, and are safer than the metal types in locations where sparks or static electricity present a hazard. A disadvantage is that they do not resist severe steam, moisture, or acid conditions.

The wood pulley with iron center lies between the metal and the wood pulley in characteristics. It is shock-absorbing and has a high coefficient of friction, but is more expensive than a cast-iron or steel pulley.

CROWNING HELPS TO KEEP BELTS ON

On paper rim pulleys with cast-iron or pressed-steel centers, the belt-contacting surface is a wear-resisting paper impregnated and hydraulically pressed. It affords a high coefficient of friction, can withstand heavy shock loads, and will resist steam, moisture, and acid fumes. In price it compares with the wood-rim, iron-center pulley.

Flat belt pulleys are always furnished with a crowned face, unless otherwise ordered—that is, the center of the face is slightly higher than the edges. Under most conditions a taper of 1/16 in. per foot is sufficient. Crown-

ing helps to correct slight misalignment and keep the belt on the pulleys. Too high a crown is destructive to both belt life and operation, and should be avoided.

Motor pulleys are likewise available in cast-iron, steel, and compressed-paper types, but for many applications the latter is to be preferred, since it is desirable, oftentimes essential, that the surface have as high a coefficient of friction as possible.

CALCULATING PULLEY SIZES

There is often a temptation to use a motor pulley smaller in diameter than is desirable from an operating standpoint. Table I shows the diameter of pulley recommended for various sizes of motors.

Since the speeds of pulleys are proportional to their diameters it is easy to calculate the sizes required for reductions or increases in speed. First, it is necessary to know or assume the speed and diameter of one pulley, and the speed or diameter of the other. Then,

1. Speed of driven pulley = $(D \times S) \div d$
2. Diameter of driven pulley = $(D \times S) \div s$
3. Speed of driving pulley = $(d \times s) \div D$
4. Diameter of driving pulley = $(d \times s) \div S$, where

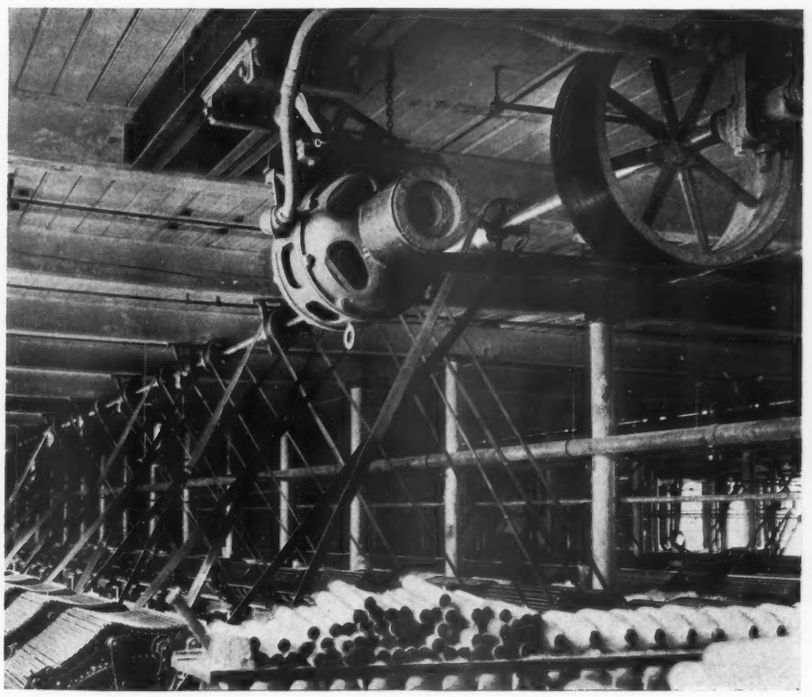
D = diameter of driving pulley
S = speed of driving pulley
d = diameter of driven pulley
s = speed of driven pulley

Squirrel-cage induction motors are generally used on lineshafts. On a 60-cycle circuit they have nominal speed ratings of 1,800, 1,200, 900, 720, and 600 r.p.m., the full-load speeds being a little lower. The higher speed motors are cheaper and more efficient than those of lower speed rating; hence, from that standpoint they are to be preferred.

Lineshaft speeds vary widely according to the conditions. As a rule, the speed of the lineshaft should be about the same as the speed of driven machines, except where these are very high or very low speed. At the same time, drives should be laid out so that belt speeds are not less than, say, 1,000 f.p.m. nor more than 5,000 f.p.m. Desirable speeds lie about midway between these limits, say, around 3,000-3,500 feet per minute.

Lineshafts may be connected directly to the driving motor, although more often they are driven through chains or belts. For connecting head-, jack-, line-, and countershafts and the driven equipment, belts are commonly used.

Fundamentally three general types of belting are available: Leather, woven fabric or fabric-base, and steel. The latter type consists of a thin, flexible band of steel. It has not found wide application and need not be considered further.



A ceiling-mounted, pivoted motor base keeps proper tension on the belt driving a textile mill lineshaft from a 75-hp. motor

Leather belts are made up in various tannages and constructions. At present there are four distinct types of leather belting: Non-waterproof oak-tanned, waterproof oak-tanned, waterproof mineral-retanned, waterproof combinations of oak and mineral-retanned leather.

CHARACTERISTICS OF LEATHER BELTING

The non-waterproof oak-tanned belting is not resistant to steam, excessive moisture, acid, or high temperatures, but may be used in the presence of mineral oil.

Waterproof oak-tanned belting differs from the regular oak-tanned in that it is made up with a waterproof cement, and the leather is treated to make it moisture-resistant. Corrosive acids exert a deleterious effect. It costs about 10 per cent more than the other.

Waterproof mineral-retanned leather has characteristics quite different from those of oak-tanned leather. It has greater power-transmitting capacity, is resistant to steam, moisture and, in less degree, to acids, has a higher coefficient of friction, and is very flexible. It costs considerably more than oak-tanned leather.

Combination oak- and mineral-retanned belting consists of an outer ply or thickness of oak-tanned leather and an inner ply of mineral-retanned leather. In this way the strength of oak-tanned leather is combined with

Table II. Recommended Effective Tension of Leather Belts Per Inch of Width

	Non-Waterproof, Oak-Tanned	*Waterproof, Oak-Tanned*	*Mineral Retanned*	*Combination Oak and Mineral Retanned*
Single:				
Light, 1/8 in.	40	40	45	
Medium, 5/32 in.	45	45	50	
Heavy, 3/16 in.	50	50	55	
Double:				
Light, 1/4 in.	60	60	65	
Medium, 5/16 in.	65	65	70	70
Heavy, 3/8 in.	75	75	80	80
Triple:				
Medium, 1/2 in.	100	100	110	
Heavy, 9/16 in.	110	110	120	

Table III. Correction Factors for Arc of Contact*

Arc of Contact, Degrees	Correction Factor	Arc of Contact, Degrees	Correction Factor
120	0.81	170	1.02
125	0.83	175	1.03
130	0.85	180	1.05
135	0.87	185	1.07
140	0.90	190	1.09
145	0.92	195	1.10
150	0.94	200	1.12
155	0.96	205	1.13
160	0.98	210	1.15
165	1.00	215	1.17

*Mechanical Power Transmission Handbook, by William Staniar

the high gripping qualities of retanned leather.

This type of belting is resistant to steam, moisture, and temperatures up to 130 deg. F., but is rapidly attacked by corrosive acid fumes.

A belt of this general type that has been used chiefly for short-center driving consists of a backing of leather or fabric to which longitudinal strips of a very soft and pliable chrome-tanned leather are attached by hollow rivets. The chrome-tanned leather strips have a very high coefficient of friction and grip the pulleys firmly, while the backing carries the load.

Table IV. Reduction in Belt Capacity Due to Centrifugal Tension

Belt Speed, Ft. per Min.	Reduction in Rated Horsepower, Per Cent
1,000	1
2,000	4
3,000	8
4,000	15
5,000	23
6,000	34
7,000	46
8,000	60
9,000	76
10,000	95

Power transmitting capacity of a given belt, or the width of belt required to transmit a given horsepower, can be determined approximately from these formulas:

$Hp. = (T \times W \times S) \div 33{,}000$,
$W = (Hp. \times 33{,}000) \div (S \times T)$
where,
T = allowable effective tension in pounds per inch of width
W = width of belt in inches
S = speed of belt in feet per minute

Table II gives the allowable effective tension per inch of width for the different types of leather belts.

When a belt is transmitting power between two pulleys the tight strand is exerting force on the driven pulley, causing it to turn, whereas the other or slack side is merely running between the pulleys. The difference in the tensions of the two sides of the belt is a measure of the power transmitted, and is termed the effective tension. In calculations it is expressed as $T_1—T_2$.

Fabric and fabric-base belts are made in a number of different types, each possessing certain characteristics and advantages.

So-called friction-surface rubber belting consists essentially of two or more thicknesses of cotton duck impregnated with a tough rubber compound. In general these belts are proof against moisture, water, and steam, can stand heat up to 130 deg. F., but deteriorate when subjected to excessive amounts of mineral oil, and are attacked by corrosive acid fumes. They can be made endless, or can be joined by rawhide or wire lacing, or metal fasteners.

In calculating the horsepower that can be transmitted by a rubber belt, the effective tension must be expressed in pounds per inch of width per ply of thickness, or pounds per ply width. Hence the formula is:

$Hp. = [W \times N \times S \times (T_1 - T_2)] \div 33{,}000$, where
W = belt width in inches
N = number of plies
S = belt speed in feet per minute
T_1 = tight side tension in pounds per ply inch
T_2 = slack side tension in pounds per ply inch
$T_1 - T_2$ = effective tension in pounds per ply inch

Good quality rubber belts are usually made up on 32-oz. duck. With this weight of duck use an effective tension of 25 lb. per inch width. For lighter duck, 28-oz., use an effective tension of 20 pounds.

In one of two other constructions that have attained prominence, one or two layers of rubber-impregnated cords are closely laid longitudinally and embedded in the rubber compound. This carcass is then incased in a rubber-frictioned duck envelope.

CORD AND FABRIC CONSTRUCTIONS

The other type of construction makes use of two sets of cords. The outer cords are heavier than the others and serve to hold the lighter but more numerous load-carrying cords against the pulleys. Both layers of cords are embedded in rubber and protected by a heavy fabric jacket.

Stitched canvas belting is composed of plies of treated cotton duck sewed

Table V. Minimum Center Distances for Belt Drives

Horsepower Transmitted	Ratio of Driver to Driven	Center Distance, in Feet	Horsepower Transmitted	Ratio of Driver to Driven	Center Distance, in Feet
1 to 4	2 to 1	4	50 to 74	2 to 1	13
	3 to 1	5		3 to 1	14
	4 to 1	7.5		4 to 1	16
	5 to 1	10		5 to 1	18
5 to 9	2 to 1	6	75 to 99	2 to 1	18
	3 to 1	8		3 to 1	20
	4 to 1	10.5		4 to 1	22
	5 to 1	12		5 to 1	24
10 to 14	2 to 1	8	100 to 124	2 to 1	20
	3 to 1	10		3 to 1	22
	4 to 1	12		4 to 1	24
	5 to 1	14		5 to 1	26
15 to 24	2 to 1	9	125 to 149	2 to 1	22
	3 to 1	11		3 to 1	24
	4 to 1	13		4 to 1	26
	5 to 1	15		5 to 1	28
25 to 39	2 to 1	10	150 to 200	2 to 1	26
	3 to 1	12		3 to 1	28
	4 to 1	14		4 to 1	30
	5 to 1	16		5 to 1	32
40 to 49	2 to 1	12			
	3 to 1	13			
	4 to 1	15			
	5 to 1	17			

together. Usually 36-oz., or slightly heavier duck is used. In the better grades such belts have high resistance to slip, are resistant to moisture, steam, heat up to 140 deg. F., and small amounts of mineral oil, but are attacked by corrosive acids and alkalis.

For calculating capacity use the formula given for rubber belting. Allowable effective tension is 28 pounds.

In another type of cotton duck belting the plies are held together with a special cement and stitched, so to speak, with metal brads closely placed in longitudinal rows. This type of belting can be made endless or laced in any desired way, resists moisture and steam, corrosive fumes, and heat up to 300 deg. F. It does not resist alkalis.

HAIR AND SOLID-WOVEN BELTING

Camel's hair belting is made by weaving cotton yarn and long camel's hair together under heavy tension. Afterward the fabric is impregnated with heavy oils that help to preserve and lubricate the fibers.

Among other characteristics camel's hair belting has a relatively high coefficient of friction, is highly elastic and flexible, moisture-, water-, and steamproof, is not affected by mineral oil, resists heat up to 300 deg. F., and is attacked only slowly by corrosive acids, although alkalis tend to make it stiff. It can not be made endless, but can be joined by wire, rawhide, or metal fasteners.

Its power transmitting capacity can be calculated by the formulas given for leather belting, using the following allowable effective tensions: For light belts, 3/16 in. thick, 40 lb.; singles, $\frac{1}{4}$ in., 50 lb.; doubles, $\frac{3}{8}$ in., 75 lb.; extra heavy, 9/16 in., 100 lb.

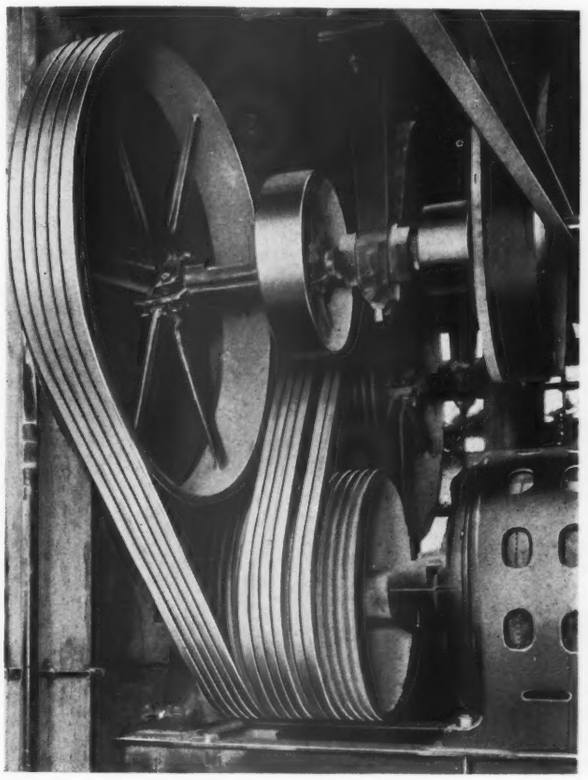
Solid-woven, impregnated cotton belting is made from long-fiber cotton woven under pressure and treated with compounds that protect and lubricate. It is flexible, can absorb shocks, is not affected by moisture, steam, or mineral oil, unless in excessive amounts, and will resist temperatures up to 200 deg. F. Corrosive acid fumes attack it.

For normal conditions the horsepower formulas given for leather belting may be used for solid-woven cotton belting, with the following allowable effective tensions per inch of width: single weight, 40 lb.; double, up to 8 in., 80 lb.; double, 8 in. and over, 100 lb.; triple, 120 lb.

CORRECTION FOR ARC OF CONTACT

Balata belting is made from tightly woven, heavy cotton duck impregnated with balata gum. It has low stretch and resists moisture and steam, but is attacked by corrosive acid fumes and mineral oil, and is affected by temperatures above 105 deg. F. If desired it can be made endless by the manufacturer, or can be laced with rawhide or wire, or joined by metal fasteners.

The formulas given for leather belting can be used for calculating the power transmission capacity or width required of balata belting. Use an allowable effective tension of 28 lb. per inch width.



Space was saved for a milling company by having a 200-hp. motor operate two lineshafts through short-center, V-belt drives

Formulas given above for calculating power transmitting capacity of belts are based on an arc of contact of 165 deg. and do not take into account the action of centrifugal force.

Reducing the arc of contact between pulley and belt reduces the latter's load-carrying capacity; so a correction factor must be applied when the arc is less than about 165 deg.

Therefore, when the approximate size of belt has been found by calculation, or from the manufacturer's tables, multiply the horsepower rating of the belt by the factor corresponding to the arc of contact as shown in Table III.

Arc of contact on the smaller pulley of a belt drive can be computed from the formula:

Arc of contact $= 180$ deg. $- [(D-d) \times 57.3] \div C$, where

D = diameter of larger pulley, in inches

d = diameter of smaller pulley, in inches

C = distance between pulley centers, in inches

EFFECT OF CENTRIFUGAL FORCE

Centrifugal force also tends to reduce the transmitting capacity of a belt at speeds much in excess of 1000 f.p.m., particularly when there is no automatic means of maintaining belt tension. Its effect varies as the square of the speed and is also dependent on the weight of the belt. When high belt speeds must be employed use the lightest belt suitable for the load.

Under ordinary conditions the percentage reductions shown in Table IV in the rated horsepower of a belt may be assumed.

There are other less tangible influences that markedly affect the load-carrying capacity of a belt drive. Size of the pulleys, coefficient of friction between pulley and belt, nature of the load (whether jerky, fluctuating, or steady), peak values, and so on all exert an influence that should not be overlooked. It is advisable, therefore, to allow a liberal factor of safety. This factor will vary from 25 to 100 per cent, and its determination is fundamentally a matter of experience and good judgment.

WATCH CENTER DISTANCES

Selection of the proper center distance between pulleys is important. Although there is room for considerable variation, both too great and too short center distances are undesirable. With an excessively long center distance the weight of the belt increases tension to an objectionable degree; also, the belt will tend to whip or sway.

Short center distances require high initial belt tension, which is not only difficult to maintain, but also leads to overheating and wear of bearings. For these and other reasons short-center, flat-belt drives are usually provided with some means of automatically maintaining the desired tension.

Minimum center distances for flat belt drives are given in Table V.

With ordinary belts on open drives speed reduction ratios should not exceed 6:1. If higher ratios are required use a jackshaft. Excessive ratios result in belt slippage and loss of power.

Belt drives operate best when they are in a plane approximating the horizontal. Vertical drives are likely to

give trouble and should always be avoided, if possible. If such drives must be used, place them at the largest possible angle from the vertical. A short center distance and some means of maintaining belt tension will help to make such drives less troublesome.

Crossed-belt drives are sometimes required to reverse the direction of rotation, or increase the arc of contact, but may cause trouble if not properly laid out. Belts that operate on very short centers or that are more than 8 in. wide should never be crossed. Have the crossing as close as possible to the midpoint between the pulleys, and do not let the reduction ratio exceed 4:1.

Quarter-turn drives should always be avoided but are sometimes required to transmit power between shafts placed at a right angle. At best more or less troublesome, they are unworkable unless expertly laid out. It is essential that the center of the face of the slack side of the driving pulley be in line with the center of the face of the tight side of the driven pulley.

Length of belt required for ordinary open drives can be calculated from the formula:

$$\text{Length in feet} = 2C + 1.57\ (D + d),$$

where

C = distance between pulley centers, in feet

D = diameter of larger pulley, in feet

d = diameter of smaller pulley, in feet

When the two pulleys have widely different diameters and the center distance is short, as with most short-center drives, the formula becomes:

$$\text{Length in feet} = 2C + 1.57\ (D + d) + [(D - d)^2 \div 4C]$$

For crossed belts use the formula:

$$\text{Length in feet} = 2C + 1.57\ (D + d) + [(D + d)^2 \div 4C]$$

Lineshafts of group drives normally operate at a fixed speed; therefore, if the driven equipment must be operated at different speeds suitable provision must be made for obtaining it. One way of accomplishing this involves the use of countershafts with step cone pulleys, giving several fixed speeds. Means for varying speed are also frequently built into production machines.

When operating requirements make it necessary to have stepless speed variation over a considerable range, one of the several available designs of variable-speed transmissions described later can easily be interposed between the group lineshaft and the driven machine.

CHAPTER THREE

When Unit Drives Are Used

WITH the individual system of driving, any one of several types and arrangements of equipment may be required. For example, the driven shafts of some machines operate at speeds sufficiently high to permit them to be connected directly to the motor shaft, through a coupling.

There are two general types of couplings, the rigid and the flexible or self-aligning. The latter type in particular is made in many different designs. Both types can be had in any size required. In general the rigid type of coupling is most widely used for connecting lineshafts and other shafting where it is necessary to maintain alignment, where the installation is of a permanent nature, or where the shafts are of different diameter.

Owing to the practical impossibility of maintaining proper alignment, motors are commonly connected through a flexible coupling to the driven machine or shaft. Such couplings are designed to take up or correct for reasonable misalignment and thus avoid bending stresses in shafts and excessive pressures on the bearings.

Flexible couplings fall into two general classes, according to the principle of operation. In one class misalignment is accommodated by the distortion or bending of some flexible or resilient material. In the other misalignment causes certain parts of the coupling to slide over each other.

In the first-named class, pins and flexible bushings, springs of various shapes, strips of leather or other material, and so on, are employed.

A typical design of the second class consists of two iron flanges with a wide groove machined across the face. A floating member in the form of a square, hollow casting slides in these grooves and transmits torque between the flanges.

In another design two toothed flanges are flexibly connected by a short length of chain of the silent or roller type, which encircles the center portion of the flanges.

WAYS TO AVOID STARTING SHOCK

The different designs of flexible couplings vary rather widely in their ability to accommodate misalignment. Some can absorb shocks; others cannot. Some are designed for high speeds, whereas others are intended for low-speed operation. Therefore, when selecting couplings the character of the misalignment, whether lateral, angular, or both, the degree of misalignment, the character of the load, amount of power to be transmitted, and other factors must be carefully considered.

When a motor is connected to its load through a coupling, chain, or speed reducer, consideration must be given to the amount of torque required to start the load and the rate of acceleration to full speed. It is desirable from the standpoint of economy to use standard induction motors and start them across the line, on full voltage. Starting in this way brings a motor up to full speed within a few seconds. However, if high torque is required to start the load and bring it up to speed, destructive stresses may be set up in all elements of the drive.

The situation is different when the drive medium is a belt. Usually belts possess enough elasticity, or will slip sufficiently, to prevent dangerous stresses on the motor or driven machine.

From the electrical side the solution of the problem may lie in the use of (1) compensator starting for squirrel-cage motors; (2) wound-rotor (slipring) motors; (3) direct-current motors; (4) a magnetic clutch.

Mechanical methods of meeting this problem are also available. Several different designs of self-actuating devices for reducing starting shock have been developed. They are available as a coupling interposed between the motor and its load, or in the form of a pulley, gear, sprocket, or sheave. The principle of operation is simple and is based on the action of centrifugal force in causing one element of the device to expand or move outward and through friction drive another element which is connected to the driven shaft. Thus the starting period for the load is considerably extended and shocks are avoided.

Other advantages of these devices include comparatively low cost, and the possibility of using smaller motors and transmission equipment, because high peaks are avoided. Some designs can be adjusted to slip or drop the load at a predetermined overload.

Frequently it is necessary to provide some means of quickly connecting or disconnecting shafts or driving elements such as pulleys or sheaves. Several different types of clutches have been designed to meet the many conditions encountered. Among these types the so-called friction clutch finds wide application in industrial power transmission work.

Designs differ quite widely, but all consist fundamentally of a driving and a driven element and a means of connecting them through friction. Driving and driven elements may take the form of concentric rings or drums or, more commonly, of parallel disks mounted at right angles to the shafts. Friction surfaces may be hard wood or asbestos.

For installations where flammable gases or abrasive dusts are present

there is available a totally inclosed clutch in which all working parts are adequately protected.

In another type of clutch the load is brought up to speed through a friction band. Further movement of the control lever causes gear teeth in the driving yoke to mesh with internal gear teeth on the driven drum. The friction band is released at the same time. In this way all possibility of slipping is avoided.

While all commercial designs of friction clutches have their good points, they are not equally applicable under all conditions. Some are designed for, or operate best at, comparatively low speeds. Some will withstand frequent operation better than others. It is necessary, therefore, to consider operating conditions very carefully when selecting friction clutches. Common mistakes lie in underestimating the maximum load to be carried, and in failing to allow enough capacity to take care of shocks. The effect of frequency of operation may also be overlooked. After complete information on operating conditions has been assembled, the clutch manufacturer's tables should be consulted for ratings, service factors, and recommended applications.

So-called jaw clutches find some application where speeds are low (60 r.p.m. or less) and shocks are not objectionable. The driving and driven members of such clutches have square or spiral jaws that engage each other. The load is picked up instantly when the clutch is engaged, resulting in a decided shock.

With magnetic clutches, engagement and disengagement of the load are accomplished by energizing or de-energizing the magnet coils. Such clutches find wide application. They pick up the load smoothly, and no attention on the part of the operator is required after current has been applied.

CHAPTER FOUR

If Speed Reduction Is Needed

IN THE majority of cases, individual drives require a reduction in speed between the motor and the driven shaft. For present purposes such drives can be divided into two classes. In one a constant, reduced speed is required; in the other, speed variation is necessary.

With the first class of drives, motor and driven shaft may be connected through a flat belt, V-belt, chain, gear, or speed reducer. Or a geared motor-reducer may be used.

When flat belts are used the center distance between shafts is usually quite short and the speed reduction is rather large. This combination makes it advisable, or necessary to use some means of automatically maintaining belt tension, or increasing the arc of contact on the smaller pulley.

AUTOMATIC BELT TENSIONING

For many years so-called idler pulleys were the most widely used means of maintaining belt tension on short-center drives. When properly placed they also increase considerably the arc of contact, and give good results.

During the past few years pivoted motor bases have come into prominence as a simple and convenient means of maintaining belt tension. These devices are available in two designs which look somewhat alike, but differ markedly in the principle of operation.

In one design the motor is mounted on two arms resting on a shaft that is pivoted on a cast or fabricated base. Since the motor is free to move for a short distance around the pivot as a center, part of its weight can be utilized to keep tension on the belt. Means of adjustment permit variation of the tension over a wide range. Any change in the length of the belt is immediately compensated for, in a horizontal drive, by a slight tilting or downward movement of the motor around the pivoted shaft. These bases can be had for wall or ceiling mounting.

With a suitable belt and a motor pulley having a high coefficient of friction, reduction ratios up to 8:1 are permissible. For best results an endless belt should be used.

PUTTING REACTION TORQUE TO WORK

The other type of pivoted motor base maintains belt tension by utilizing the reaction torque of the motor, which is equal to the force exerted on the belt by the driving pulley. The motor is suspended in a cradle that is pivoted close to the axis of the motor and is free to move through a small arc.

Bases are fabricated from steel plate, while forged steel cranks support the cradle and motor arms. Bronze bearings of the ball-and-socket type support the moving parts. Necessary adjustments are provided for aligning the drive and taking up belt stretch. These bases can also be mounted horizontally, or on wall or ceiling.

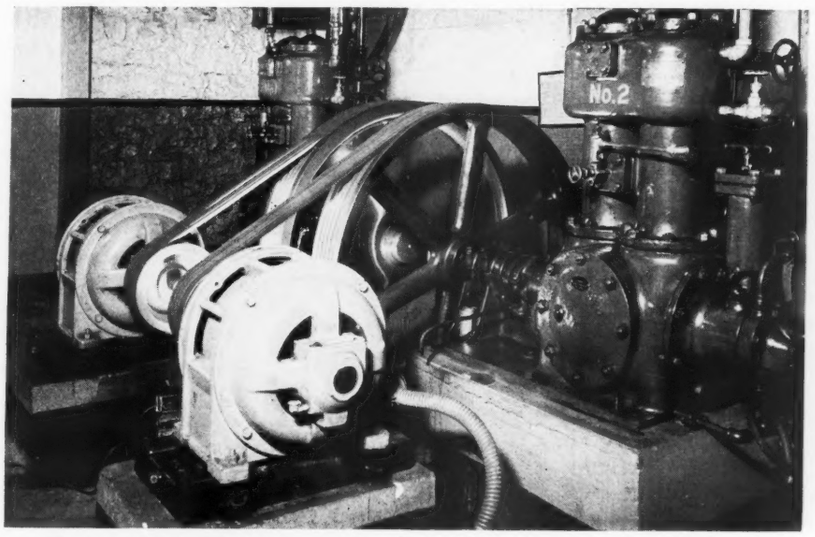
The no-load tension on the belt is quite small, but when the motor is started it tends to swing around its pivot axis, away from the driven pulley, so that the center distance is increased and elongation of the belt is flexibly accommodated.

V-BELTS OPERATE DIFFERENTLY

The V-belt drive comprises one or more V-shaped belts running in grooved cast-iron or steel sheaves. Various constructions are employed for the belts, but in general they are composed of cotton cords impregnated with and embedded in rubber, and covered with impregnated fabric.

A V-belt operates on a different principle than flat belts. As it seats in the groove the top of the belt is under tension, while the bottom is compressed. As a result the sides tend to bulge, so that the walls of the groove are gripped tightly. For this reason grooves in sheaves must be cut accurately and given a smooth finish. When installing V-belt drives, the sheaves must be aligned exactly.

On quarter-turn drives V-belts serve well, one advantage being that they can be laid out on very short centers. However, centers should not be less than $6(D + W)$, where D is the pitch diameter of the large sheave, and W is the width of the band of belts. An idler pulley or sheave is necessary when the



Short center distance does not bother these V-belts of special design, which are driving refrigeration machines

This silent chain works in a steel mill, is 3-in. pitch, 12 in. wide, and transmits 500 hp. between the 150-r.p.m. motor and the 74-r.p.m. shaft

ratios are large. As a rule it should bear against the slack side.

On installations where the ratios are large and the center distance is very short, a flat-faced instead of grooved driven pulley may be used, resulting in a saving in first cost. If the center distance is appreciably more than the diameter of the larger pulley, the resultant decrease in its arc of contact will necessitate the use of a larger number of strands, to prevent slipping.

These belts are resistant to moisture, although excessive amounts tend to reduce the coefficient of friction, and withstand belt temperatures up to 180 deg. F. Some makes resist oil better than others, but as a rule oil, grease, and rubber solvents are harmful.

When laying out a V-belt drive, allow a center-distance adjustment of at least 10 per cent of the total center distance between sheaves, to make installation easier and permit stretch to be taken up. For ordinary drives a center distance between sheaves that is somewhat greater than the diameter of the larger sheave, but less than the sum of the diameters of the two sheaves, will usually be satisfactory. Longer or shorter centers may be used.

CHAINS FOR POWER TRANSMISSION

Information needed when laying out a V-belt drive includes the horsepower to be transmitted, speed of driving and driven sheaves, distance between centers of sheaves, and the character of the load, such as unusually high starting torque, shock, pulsating, or steady. With these data, the size and number of strands can be found by consulting the manufacturer's tables.

Chains have long been used to transmit power between shafts, and several types have been developed to meet different requirements. In general, chain drives provide a simple means of obtaining a positive and unvarying speed ratio between shafts. They can be operated on very long or very short center distances, and can stand high temperatures and highly adverse atmospheric conditions.

The silent-type chains vary somewhat in details, but all consist of hardened steel links joined by special pins. These chains run on cut-tooth steel or cast-iron sprockets.

Economical operating speeds range from 1,200 to 2,000 f.p.m. Operation at speeds below 1,200 f.p.m. is entirely successful, but it will be more economical to use another and cheaper type of chain. Ratios up to 7:1 may be used.

Finished steel roller chains are composed of alternate assemblies of highly finished hardened rollers and pin links. This type, as well as the silent, can be had in multiple widths and operates on cut-tooth sprockets. For long life and low maintenance, chain speed should not exceed 1,400 f.p.m. Usually it is advisable not to exceed ratios of 8:1.

Both the silent and the finished steel roller types of chains are precision-made, high-speed transmission mediums, and they require adequate lubrication. On high-speed drives this is best provided by the use of an oil-retaining casing.

CHOOSING PROPER SPEED REDUCER

The light steel roller, heavy steel roller, and malleable-iron link types of chains are comparatively inexpensive and have been developed to provide a wide range of capacity at low speeds.

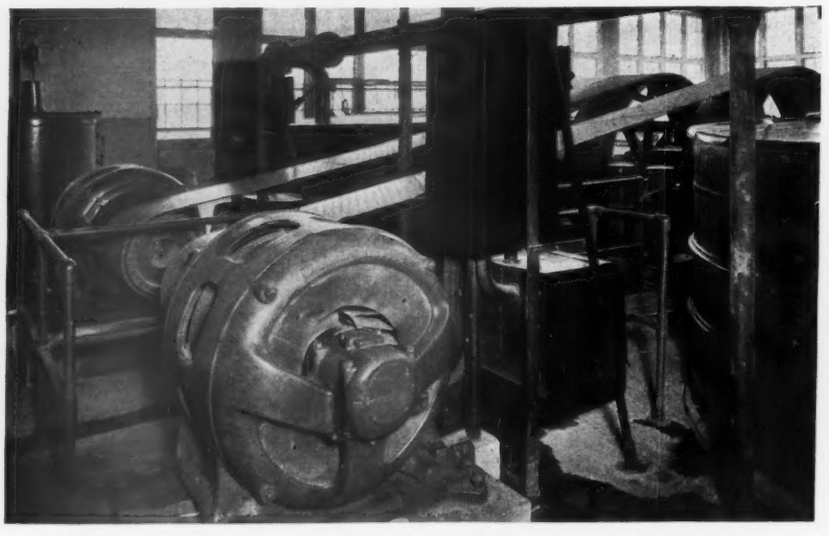
With the light steel roller type it is desirable not to exceed a chain speed of 700 f.p.m., or a ratio of 5:1.

The heavy steel roller chain is more rugged than the preceding, but desirable speeds and ratios are the same.

Malleable-iron link chains are primarily suitable for low-power applications where the chain speed does not exceed about 400 f.p.m. and the ratio is not more than 5:1.

A number of different factors have to be taken into account when laying out chain drives; it is therefore advisable to consult the manufacturer's tables for ratings and recommendations.

Speed reducers offer the advantage of minimum power loss between the prime mover and its load, low maintenance, silent operation, conservation of space, and ability to operate under extremely



Increase in load on the beaters in a paper mill presented a problem that was eventually solved by the use of a combination oak- and chrome-tanned leather belt of special design

adverse conditions, since all working parts are inclosed.

Different types and combinations of gears are employed, depending on such factors as reduction ratio, power to be transmitted, and relative position required for the input and output shafts.

CAPACITIES AND RATIOS

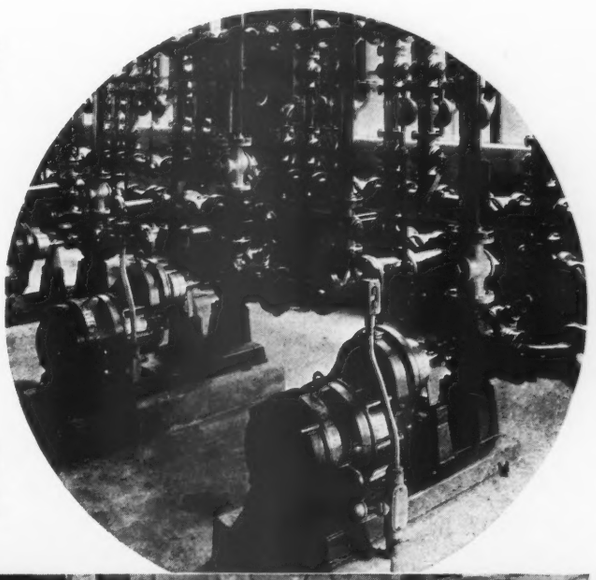
Spur gear units are made in planetary and non-planetary designs. With the former, input speeds range up to 1,800 r.p.m. Capacities and speeds obtainable are: Single reduction, fractional to 150 hp., 4:1 to 10:1 ratio: double reduction, fractional to 100 hp., 10:1 to 100:1 ratio; triple reduction, fractional to 25 hp., 100:1 to 500:1.

In the non-planetary type, single-reduction units range from fractional to 150 hp., 4:1 to 7:1 ratio; double reduction, 5 to 100 hp., 7:1 to 20:1 ratio; triple-reduction, 5 to 50 hp., 20:1 to 100:1 ratio.

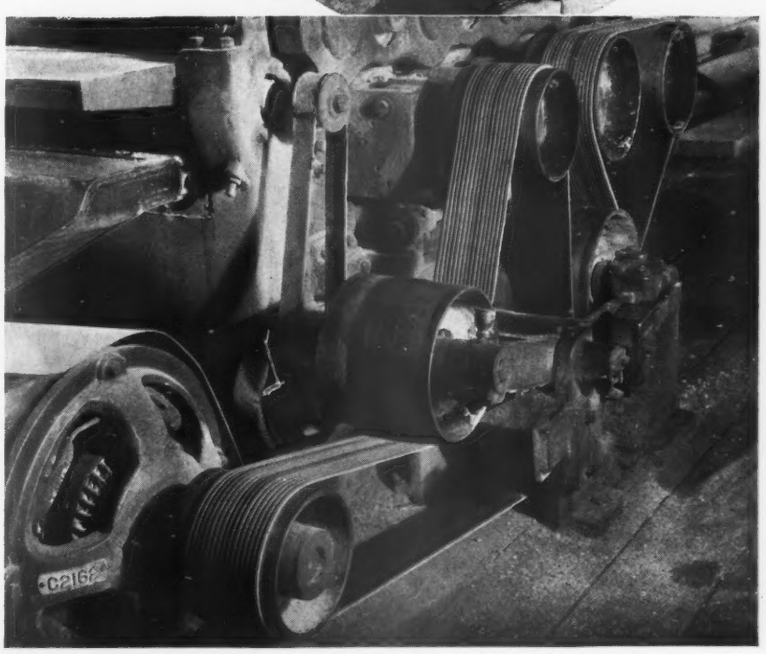
Worms of worm gear units may be driven at speeds up to 6,000 r.p.m. Ratios available are: Single reduction, 3.5:1 to 100:1; double reduction, 100:1 to 10,000:1. Standard units are available in fractional to 400-hp. ratings. Horsepower rating of a unit depends on the service conditions, and should follow the maker's recommendations.

Helical gears are used in some units in which input and output shafts must be at right angles. Single-reduction units are available in ratings up to 350 hp., 1.5:1 to 5.28:1 ratio; double-reduction, up to 200 hp., 5.7:1 to 52.1:1 ratio; triple-reduction, up to 25 hp., 56.1:1 to 515:1 ratio.

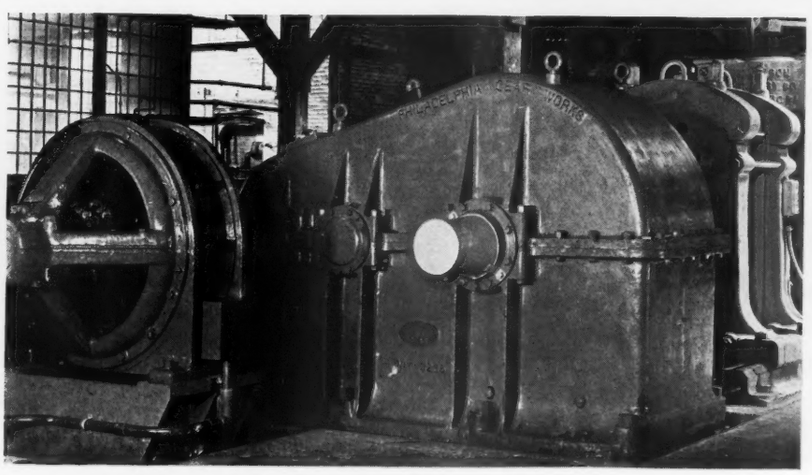
Herringbone gear units are made with single, double, and triple reductions. Shafts are offset in the single and triple reduction types, in line when double reduction is used. Horsepower capacity and ratios are: single reduction, 1½ to 700 hp., 1.7:1 to 10:1 ratio; double reduction, 3 to 1,300 hp., 10:1 to 70:1 ratio; triple reduction, ½ to 75 hp., 70:1 to 320:1 ratio.



Geared motor-reducers drive a battery of rotary pumps in a lubricating oil refinery



A rubber-impregnated fabric belt of cord construction is used on a sanding machine in a woodworking plant



Here is a 40.8:1 double-reduction herringbone speed reducer, rated 150 hp., driving a rolling mill

Ratings of speed reducers depend to a considerable extent on the number of hours of continuous service, the prime mover, and kind of machine driven or nature of load. Manufacturer's tables should be consulted for ratings and service factors to be applied.

Motorized gear reductions, often referred to as geared motor-reducers, in which gear unit and motor are combined in one unit, have become widely used during the past few years. These units can be had in different designs for vertical or horizontal drives. They can be direct-connected to their load, or arranged to drive through belts, chains or gears. Advantages include extreme compactness, permanent connection and alignment of motor and reduction gears, without a coupling.

Standard units are available in ratios that range from 1.2:1 to 450:1, and ratings from ½ to 75 hp.

CHAPTER FIVE

Obtaining Variable Speeds

SPEED VARIATION is frequently required on individual drives, and may be obtained in several different ways. Of the commercial types of a.c. motors, the wound-rotor and the brush-shifting types permit sufficient adjustment of speed for some applications. When direct current is available, the shunt-wound motor can be used to provide wide adjustment and close control of speed.

There are now available several multi-speed units consisting of a constant-speed motor with in-built mechanism for stepless variation of speed through a considerable range.

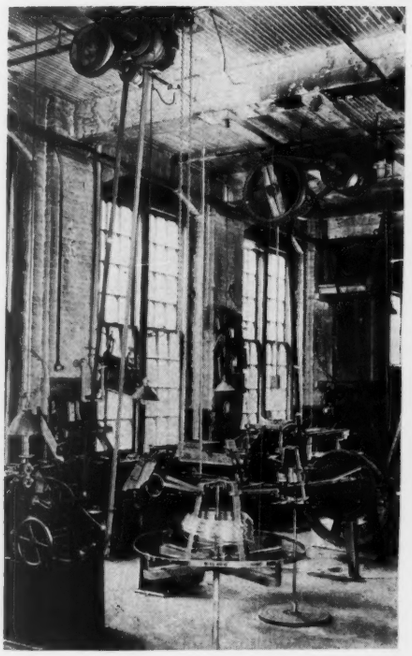
In one typical design hardened steel rollers bear on and transmit power between steel races, one of which is connected to the motor shaft while the other is fastened to the output shaft. Tilting the rollers shifts the point of contact of the rollers farther away from the circumference of one race and closer to it on the other. Through a combination of manual and automatic control, the unit can be set to deliver any speed between the high and low limits, before or after starting. When power is shut off the control automatically shifts back to the low-speed position, in which starting torque is highest. The control can also be adjusted to shift from low speed to any desired higher speed within a definite time.

Units with ratios of 6:1 and 10:1 are available, so that when powered with a standard, 1,750-r.p.m. motor any speed between 600 and 3,600 or 560 and 5,600 r.p.m. can be obtained. It can be had in ratings up to 20 hp. at 3,600 r.p.m., or 3 hp. at 5,600 r.p.m.

PITCH DIAMETER IS CHANGED

Several designs of variable-speed transmissions have been on the market for some time. Interposed between the prime mover and its load they make it possible to drive the latter at an infinite number of speeds between the upper and lower limits.

Essentially these devices consist of two sets of cone-faced disks mounted on the input and output shafts, respectively. The distance between each of the opposing disks can be varied by operating the control mechanism, which is so arranged that when one set of disks is being separated the other two disks are being brought closer together. In this way the effective pitch diameters of the disks can be changed to give the speed desired. Power is transmitted from one set of disks to the other by some flexible medium serving the function of a belt.



Speed variation for the torsion machines and coilers in a wire spring plant is provided by variable-speed pulleys on the driving motors

Variable-speed transmissions of these types may be had in ratings from fractional to 100 hp., and ratios up to 16:1. Control may be manual, automatic, or remote.

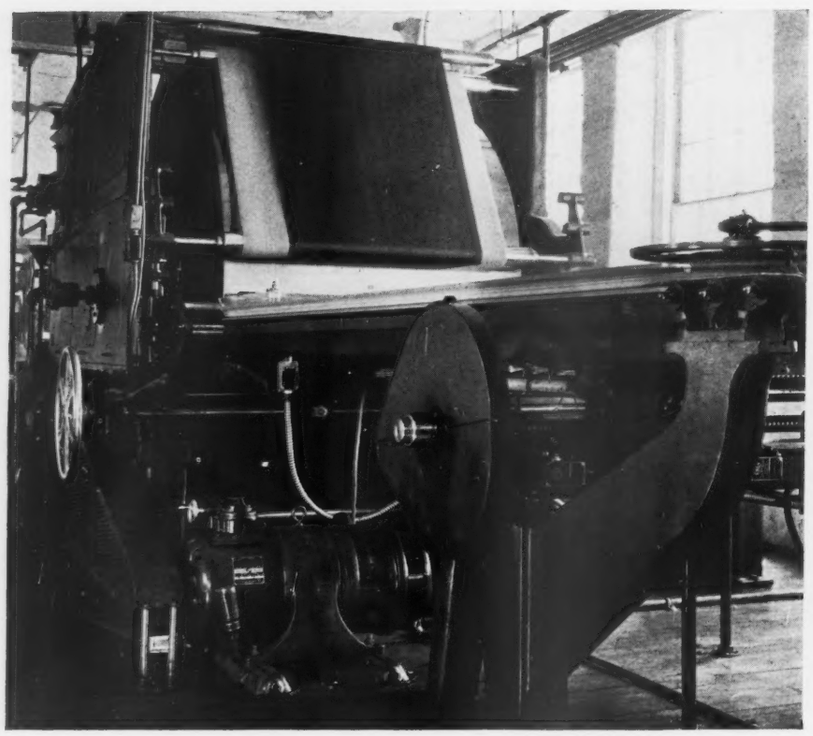
The general principle used in these variable-speed devices has now been applied to V-belt sheaves. Instead of being solid, as in the ordinary drive, the sheaves are made up of cone-shaped disks whose distance from each other, and therefore the effective pitch diameter, can be varied through a simple control, which automatically moves the motor forward or back to compensate for the change in length of the belt.

In one make, the diameter of one or both sheaves can be adjusted to give a speed variation of 15 to 25 per cent for each sheave. Ratings are from 1 to 60 hp.

Another design in which the motor sheave alone is adjustable, the V-belt running over a flat pulley on the driven shaft, can be had in ratings up to 7½ hp., with a 3:1 speed range.

DOING IT HYDRAULICALLY

Hydraulic transmissions have found a limited application to drives that require extremely smooth starting and infinite speed variation. Such units comprise a variable-delivery pump driven by a motor which delivers oil under high pressure to one or more hydraulic motors. Accurate control of the oil flow makes it possible to secure great flexibility and smoothness of operation.



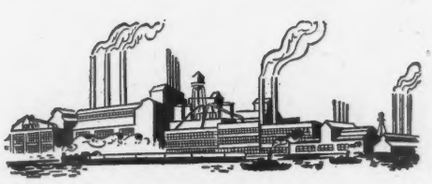
The motorized variable-speed drive for this dryer provides an infinite number of speeds between the upper and lower limits of its capacity

PERSONNEL MANAGEMENT

AUTHOR

J. E. WALTERS

Director of Personnel, School of Engineering
Professor of Personnel Administration
Purdue University



TWENTY-FIRST IN THE SERIES OF

FACTORY MANAGEMENT and MAINTENANCE

PLANT OPERATION LIBRARY

CHAPTER ONE

Personnel Management Pays Its Way

THE MANAGEMENT of men involves the application of the scientific method to the human problems. It collects facts and uses them for the purpose of preventing personnel difficulties from arising. It is preventive in nature. The facts are obtained about applicants before employment to prevent the hiring of men unsuited for the work. Physical examinations and health procedures are maintained to prevent later physical difficulties and the spreading of disease. Safety activities prevent accidents before they can happen. Employee representation gives an outlet for grievances and complaints before a break occurs.

Personnel management, then, is the application of the scientific method to the human problems of obtaining an efficient force adapted to the organization for which it was intended, of maintaining this force in relations mutually harmonious and profitable to employer and employee, and of making adequate provision for employees after they have served the organization over the period of greatest usefulness. To accomplish these ends, industry maintains certain personnel activities and procedures which, carried on by individual managers, will naturally vary according to the special nature and needs of the different companies in which they are used. Figures 1 and 2 depict outstanding personnel organizations.

NOT PATERNALISM

Personnel work is a straight business proposition. It is not a philanthropic or paternalistic phase of management. It pays its own way. The total cost of personnel activities in 63 companies surveyed in 1934 (see Table I) wa $14.06 per employee per year or 1.85 per cent of payroll. In smaller companies employing from 1 to 750, the cost was $26.66 per employee per year; for companies above 750, between $11 and $12 per employee. The United States Bureau of Labor Statistics found the average cost of personnel work in 430 establishments in 1926 to be $27.[1] The National Industrial Conference Board in 1927 found the average for small companies to be $26.65.[2] The cost of personnel work is closely related to the number of activities maintained. A median of 52 activities (40 per cent) of the 128 activities investigated were carried on by these 63 companies reporting cost data.

Since one may question whether personnel actually does pay to the extent shown, let us consider briefly how personnel work pays.

One of the chief reasons for the employment department is that it decreases labor turnover, preventing separations in good times and making wise layoffs during depressions. Excessive labor turnover, either separations or layoffs, is expensive to the company because of the cost of hiring, training, extra labor, and extra investment. In bad times it involves expense to the company or the community to provide unemployment relief. For the company, the cost ranges in normal times from $250 for a highly skilled employee to $8.50 for ordinary labor. The estimated cost of labor turnover for the hourly rate employees of a single plant of a boiler manufacturer was figured to be $95 per separation. The average turnover rate of 169 metal firms of 184,000 employees in 1926 was approximately 140 per cent. In 1926, labor turnover was about 50 per cent as judged from the Bureau of Labor Statistics.

From these figures a labor turnover of 75 per cent would be about average. Some companies have been able to reduce labor turnover as much as 70 per cent. A large steel company had a labor turnover of 90 per cent in 1920 and 19 per cent in 1928. Therefore, by scientific employment methods, it would not be unreasonable to expect a decrease in labor turnover of 25 per cent. In the plant of 1,000 employees that would be a decrease in hiring, training, and firing or layoff of 250 employees. At an average of $40 per employee that would mean a saving to the company, in the long run, of $10,000 per year.

Disregarding all other reasons for having an employment department, that company could spend $10,000 on employment and realize its money's worth. In that sense, then, the department would be paying for itself in dollars and cents.

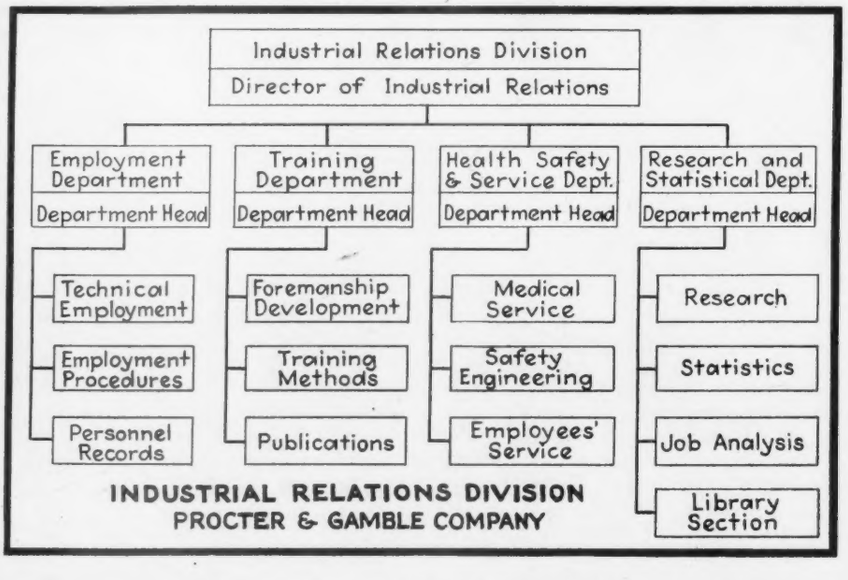
The company would also be obtaining a more efficient force of workers for the other jobs in the plant. If the company obtained only 1 per cent more efficient employees by proper hiring, that 1 per cent increase in efficiency for the year would amount to some $12,000 for the company. But let us forget that $12,000 because of the increased efficiency through proper employment methods, and stick mainly to those activities that we can calculate more accurately.

$40 A DAY

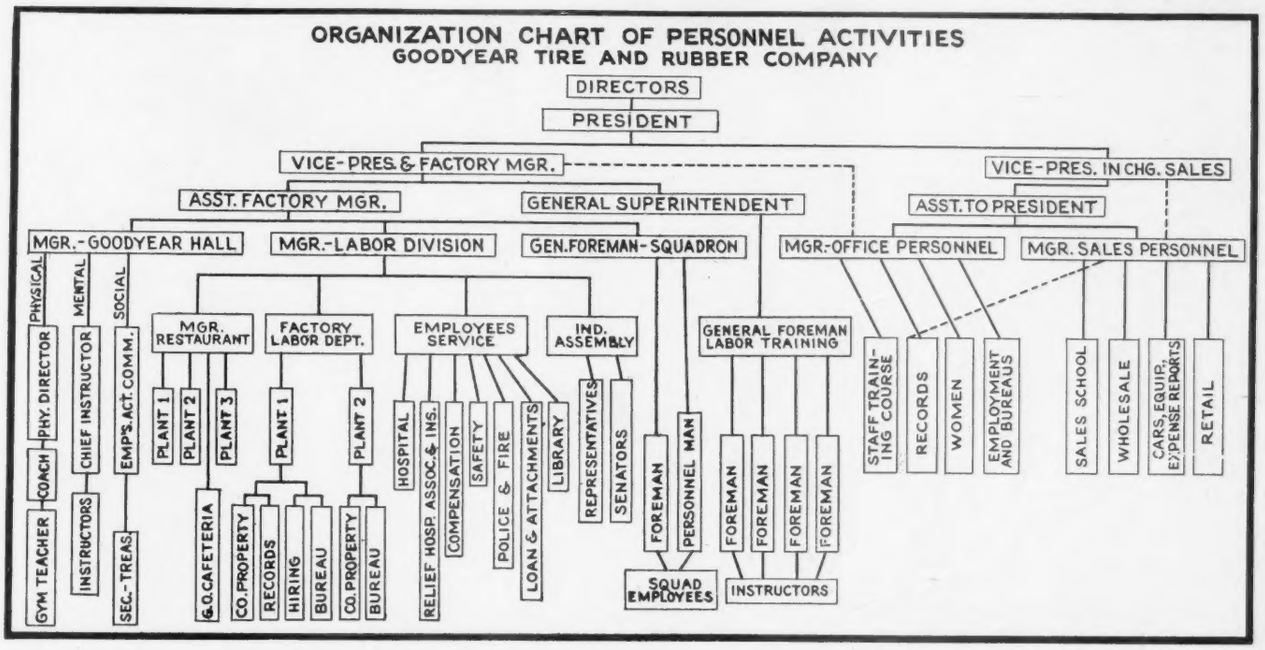
Every company has a plan for paying wages. By reconsideration of the wage-setting and payment processes, such as from the straight hourly rate to an individual, group, or efficiency bonus, it is not unreasonable to expect an increase of 2 per cent in efficiency. If half of the employees were included in the change, it would be an average of 1 per cent increase. Based upon the Industrial Conference Board's figures, let us consider an average day's wages at about $4. With a saving of 1 per cent for 1,000 men the total would be $40 per day for the entire plant. For the year's period of 280 working days the total amount saved for the year would be $11,200.

In many plants it is not unusual to grant employees a week's sick leave with pay. With the installation of health promotion activities by the

FIGURE 1



[1] *Health and Recreational Activities in Industrial Establishment, 1926.* Bulletin No. 458, page 86.
[2] *Industrial Relations Program in Small Plants.* New York: 1929, page 40.



company, it is not unreasonable to expect that absence because of sickness can be reduced 2 days per year per man, making the average sickness 5 days, or a saving of 2 days. For the 1,000 men that would be a saving of 2,000 man days, at $4 per day or $8.00. The health department, then, could be considered worth a minimum of $8,000 to the company.

Most industrial concerns have some accidents during the year. There will be a greater number of lost-time injuries where safety education and activities are not promulgated. In a company of 1,000 employees without safety activities, 50 lost-time injuries per year might easily be expected. According to the National Safety Council, companies have been able on the average to reduce accidents by about 50 per cent. At that rate we should prevent 25 lost-time accidents in our company of 1,000 employees. Mr. Heinrich in the Monthly Labor Review of November, 1930, gave the total direct cost of an average injury as $246. By preventing 25 accidents per year, an annual saving of $6,150 would result.

Another company paid out $1,700 in one year to employees for suggestions. They gave the employee 10 per cent of the saving resulting from the suggestions. In other words, that company saved $17,000 that year from the suggestions of the employees. For the company of 1,000 employees it would not be unreasonable to expect to pay $300 to employees for suggestions which, at 10 per cent, would be a saving of $3,000 to the company.

Allowing a large factor of safety, let us consider employee development through such activities as ratings, pensions, thrift plans, transfers, personnel records, and lunchrooms. One company, by giving a hot lunch free to its employees increased production of two departments 10 per cent during the afternoon. The lunch cost 35c, but the company made nearly twice that amount through increased efficiency. If, then, through all these employee developmental activities we could without unreasonableness expect an increase in efficiency of one-half of 1 per cent, that would mean another increase of $6,000 for the plant of 1,000 men for the year.

An over-all view of these activities would show the following savings or increases:

Employment (reduction of labor turnover)	$10,000
Change in wage incentive	11,200
Health service	8,000
Safety	6,150
Suggestion system	2,700
Employee development	6,000
Total	$44,050

From the viewpoint of the directors, they could spend $44,050 for personnel work—employment, wage changes, health, safety, suggestions, and employees' development. Let us assume that they are spending $27,000 for these services, the average cost in this investigation. In that case they would be making a profit of $17,050 on their personnel activities. Then the personnel work would not only pay for itself in dollars and cents but would also be making a profit.

DOLLARS-AND-CENTS DIVIDENDS

There may be too many if's, and's, and assumptions in these cost calculations, but if personnel work is considered from a dollars-and-cents viewpoint, with reference to a centralized employment service, a modern wage incentive plan, a health and safety division, a suggestion system, employee development services, and the other personnel activities, it can be shown to pay.

CHAPTER TWO

Selection of Employees

EFFECTIVE selection of employees is one of the most important phases of the management of men. If an efficient employee is hired, his management is easier than that of an inefficient one. If an inefficient employee is hired, then even good management may not be able to manage well. In general, effective selection will result from the application of scientific methods to employment problems.

As in the other phases of management of men, the application of scientific methods to selection applies more to group efficiency than to individual efficiency. For example, the use of a good clerical test to employ clerks may not be effective with a particular

applicant, but it may prove excellent in securing a higher percentage of efficient clerks from a group of 100 than if the test were not used. In other words, personnel activities should be looked upon as an aid in predicting group performance. With the use of the test the manager may select 75 efficient employees out of 100, whereas without the test he may select only 50. In this case he would be increasing the efficiency of his selection 25 per cent by the use of the test. The clerical test was used as an example, but the same principle will apply to the other employment and personnel activities.

HIRING METHODS

Employment procedure generally involves the following:

1. Development of a source of personnel supply.
2. Interviewing.
3. Tests and examinations.
4. Selection.
5. Introduction to the job.

Before the proper selection of an employee can be made, the manager must have a number of persons from whom to select. The better the group, the more efficient the person selected will likely be. The two general sources of personnel supply are those from within the company and those from outside. From within the company a manager has the present employees who can be transferred and trained, the friends of present employees, and previous employees of the company. If the supply of efficient personnel available from within is not adequate, outside sources can be developed by considering applicants who apply at the plant and by mail; by advertising in newspapers and trade journals; by keeping in touch with schools and colleges, employment agencies, lodges, churches, trade and labor organizations; by scouting and considering layoffs from other companies.

If a manager systematically develops the sources of personnel supply by using as many of them as he possibly can, it is more than likely that he will have a better group of people from whom to select than if he were to take the first person who comes along.

After these sources have been developed, one of the first procedures is an interview with the applicants. As shown in a survey of 233 companies, 90 per cent interviewed applicants.

Proficiency in interviewing can be learned. It is an art, not an exact science, and always involves the play of individuality and initiative. Fundamentally, the purposes of the interview are to find out facts, to inform the interviewee, and to motivate him. In the employment interview all three uses should be employed. The interviewer should find out facts about the applicant, inform the applicant sufficiently about the work and the company, and motivate the interviewee in or out of the company. In interviewing, the following instructional principles[3] have been found effective:

1. Know as many as possible objective criteria and subjective viewpoints about the applicant in advance of the interview. Before an interview with an applicant, study his application blank and any other records or opinions that can be obtained, as well as information that may assist you in finding facts about him.

2. Prepare a schedule and list of questions for the interview, or have available job specifications of the work to be done. It is important and valuable to have a definite program for the interview.

3. Make appointments in advance wherever possible, for time is saved in seeing the applicant promptly and in shortening preliminary explanations.

4. Provide privacy for every interview.

5. Take the applicant's point of view. Try to put yourself in his place. Without that there may be a misunderstanding.

6. Examine and discount your own prejudices. Are your ideas warped on any subject that you must discuss with the applicant? If so, try to keep the applicant from knowing them. Keep an open mind, which is indispensable to interviewers.

7. Gain and deserve the applicant's confidence by showing evidence of genuine confidence and interest in him. One method is to establish pleasant associations and mutual confidence. Do not interview the applicant when he is angry, or when you are peeved. Congenial fellowship develops a favorable attitude in both interviewer and interviewee.

8. Help the applicant feel at ease and ready to talk. First, be at ease yourself and make it apparent. Begin with pleasant topics. Try to find mutual likes and interests.

9. Do not ask questions directly until you think the applicant is ready to give the desired information and to give it accurately. Listening by the interviewer is important. Let the interviewee tell his story. Then help him to supplement it.

10. Keep on the subject of the interview. When necessary, ask a question or make a suggestion that will lead back to the general subject of the interview. Take pains to phrase questions so that they are easily understood. Make sure that the applicant understands them. Avoid implying the answers to your question. If you offer alternative answers, phrase them so that neither one is acceptable to him. Give him a chance to express his own viewpoint in the matter. Look for and scrutinize the full meaning of each statement. Give him an opportunity to qualify his answers. Check his answers whenever possible.

11. Be straightforward and frank rather than shrewd and clever. Do not try to deceive or trick the interviewee by your questions. Tell him frankly the purpose of the interview.

12. Avoid impertinence. Help the

[3] Adapted from W. V. Bingham and B. V. Moore, *How to Interview*. New York City: Harper and Brothers. 1931.

Table I. Average Cost per Employee of Selected Personnel Activities and of All Personnel Activities in 1933 *

Activities	Companies with 1 to 750 Employees		Companies with 751 to 2,000 Employees		Companies with over 2,000 Employees		Total Companies	
	Number of Companies	Cost per Employee	Number of Companies	Cost per Employee	Number of Companies	Cost per Employee	Number of Companies	Cost per Employee
Employment Procedure	16	$4.50	25	$2.69	19	$1.92	60	$2.75
Medical Service	22	2.50	29	3.42	22	2.42	73	2.70
Training Activities	10	1.00	7	0.94	6	0.75	23	0.85
Safety Activities	15	0.90	19	0.46	12	0.56	46	0.70
Service-Welfare Activities	10	2.00	13	2.50	8	0.63	31	1.75
Benefits	7	3.25	14	3.25	10	3.50	31	3.31
Pensions	13	9.50	22	13.00	16	7.50	51	10.33
Group Life Insurance	23	6.75	28	6.33	18	5.66	69	6.25
Unemployment Relief	6	5.00	4	1.75	7	0.56	17	3.13
Profit Sharing	2	17.70	3	49.00	.....	.....	5	34.50
Total Cost of Personnel Activities per Year	18	$26.66	28	$11.25	17	$11.87	63	$14.06

* J. E. Walters, Purdue University in collaboration with Research Staff of the National Industrial Conference Board (247 Park Ave., New York City).

applicant realize his responsibility. Record all data from interview at once, or at the earliest opportunity. This can be done by following your schedule for the interview.

13. Allow sufficient time for the interview. Do not rush it through. Get all the facts, yet keep control of the interview. Keep the applicant aware of the definite purpose which should be attained in the limited time. Watch for additional information and new leads in his casual remarks. Confirm and summarize the interview. Check the results whenever possible. Place the information where it can be used later.

From the standpoint of the general purposes of the interview, the manager may be able to find out facts about the applicant that will qualify or disqualify him for the work. He might give him such information about the company so that it will motivate him to seek further employment with the company or another concern. The ideal result of the interview would be that the interviewee is sufficiently motivated to make the proper decision himself as to whether he is or is not qualified for the work. If a manager or employer considers the principles given above, it is more than likely that he will have a more effective interview.

Interviewing is also used periodically to check the attitudes of employees, and to discover difficulties in management which are indicated by employees leaving the organization. These interviews may aid in finding management difficulties and in improving them and the morale involved.

VALUE OF CROSS-QUESTIONING

During the interview a number of procedures may be used to aid the interviewer in controlling the interview. He may test the honesty of the employee by cross-questioning. However, this should be done in such a way, if possible, to prevent the applicant from knowing that he is being cross-questioned. The courts have used this method effectively. If the applicant is aggressive in the interview, he might be put on the defensive by questioning. A question usually puts the applicant on the defense to answer it. Besides these, the interviewer may look for the causes of "defense mechanisms" and apologies. However, all of the interviewing procedure should be as free and easy as possible.

Although the interview should not be the entire basis for employment, it can be used to determine evident disqualification. For example, using an extreme case, an interviewer might readily determine whether a man is a ditch digger or not from his build, his dress, general make-up, etc. However, as most abilities and aptitudes center around the average, it is difficult to tell from a brief interview whether or not an applicant is suitable for the work. For adequate selection, the manager must consider the various factors involved.

Before proper selection can be made, there must be a number of persons from whom to choose. The better the group, the better the person selected will likely be. An important part of the employment manager's job is to develop the sources of personnel supply

Personnel factors to be considered in selection are shown in Table II[4]. If an employer omits any of these factors, it may be that that one will cause him to secure a less efficient employee than if he had considered all of them. From the methods by which these factors are determined as given in the third column of Table II, we can see that, in general, the principal methods of determining these factors are by the application blank, interviews, references, tests and examinations, and ratings.

The application blank properly checked and verified should give educational and personal information about the applicant. In general, the interview may show an employer that the applicant is stupid or mentally alert, at least during the interview. Of course, one way to tell whether a person has the intelligence and the ability to do the job is actually to try him on the job. If he does the work well, he is qualified from the standpoint of intelligence and ability; if he does not, he isn't qualified. The introduction of the man to the job, trying him out, and training him for the work is usually expensive and inefficient if the man is not fitted for the job. If the employer can find tests, examinations, or other procedures that will predict a man's intelligence and ability to do the job before he is assigned to it, the employer can save that employment and training expense.

This last idea has led to the use by some companies of tests and examinations to determine intelligence, abilities, and trade aptitudes. The many kinds of employment tests are classified according to purpose of the test; source of the ability tested; proficiency or capacity necessary; abilities measured, such as motor or intellectual abilities, attention, will, and emotional traits; methods of presentation, such as oral, written, or performance tests; type of response, such as free response and constrained response; and methods of administration, such as individual or group.

SUGGESTED TESTS

Hundreds of tests are in existence at the present time. Some of those used in industry are the Otis Self-Administering Test of Mental Ability, the Revised Alpha Examination, the Thorndike Intelligence Test, and the Kuhlmann-Anderson Test. Besides the general intelligence tests there are many tests of special abilities, interests, and personality, such as the O'Connor Wiggly Block and Dexterity Test, the Stenquist Mechanical Aptitude and Assembly Tests, the Strong Vocational Interest Test, the Bernreuter Personality Inventory, and the Thurstone Personality Schedule.

In an attempt to determine a per-

[4] J. E. Walters, *Applied Personnel Administration*. New York: John Wiley & Sons, 1931, page 84.

son's ability or capacity to perform a standard task in a certain trade, trade tests have been developed. These tests may take the forms of oral, written, picture, or performance tests, or their combinations. An extract from an oral trade test for a bench hand follows:

1. *Q.* What do you call a split pin used to keep a nut from working off?
   A. Cotter.
2. *Q.* What do you call the first tap used to thread a hole in steel?
   A. Taper.
3. *Q.* In what way are the invisible parts of a tool shown on a blueprint?
   A. Dotted line.
4. *Q.* What is the best kind of chisel to use to cut a keyway by hand?
   A. Cape.
5. *Q.* What happens to a hole if one lip of a drill is ground off center?
   A. Too large (oversize).

Written tests are similar to the oral except that the answers are written. In the picture tests, pictures of tools and parts of the machinery involved are shown to the applicant, who is expected to name and explain them.

Performance tests involve the construction, assembly, or manipulation of a standardized part or task of the trade, or performance of the same functions or operations as those found in the trade except on a model or miniature. Examples of trade tests are those for pipe fitter, machinist, and chauffeur. The pipe fitter's test involves the use of two heads, four elbows, eight pieces of pipe, and the pipe fitter's tools. The candidate is asked to make up a radiator coil. His proficiency is based upon the time required to put the coil together correctly. The ideal trade test would be a test that would require exactly the same mental, physical, and other requirements as the actual job, but in an abbreviated manner. Strength tests measure the strength of hands and back. The physical examination is given to determine the physical condition of the applicant. Rating scales are used to determine personality and character traits. The construction of tests involves knowledge and experience, and should not be attempted without proper training and education.

TO BE USED WITH CARE

Although intelligence, ability, and trade tests may aid in selecting more efficient men, they should not be used as an actual basis for employment unless their reliability and validity have been proved to be sufficiently high to warrant their use. If test results are used as an aid in conjunction with the various other personnel factors to be considered, the combined procedures should result in efficient selection.

After a number of applicants have been interviewed, tested, and examined, the employer has then to select the best. This may be done effectively by making a list of the men and their scores on the various personnel factors. The total of these various factors for each man will be an indication of his qualifications for the job; the higher the total is, the higher, apparently, will be his qualifications for the job. The essential factors will vary for different jobs. For example, in actual practice, intelligence may not be an asset for certain laboring jobs, because a man with high intelligence may not stay permanently on these jobs. In general, however, the person or persons should be selected who are the highest on the greatest number of qualifications for that particular job.

In the past some doubtful methods have been used and are being used even today in selection—such things as "character analysis," physiognomy, phrenology, and graphology. Although there may be something to them, their authenticity has been doubted principally because they are not based upon scientific experimentation and verification.

INTRODUCTION TO JOB

After the employee has gone through the process of applying, being interviewed, tested, and finally selected through a consideration of the various personnel factors, he has yet to be introduced to the job. In many companies even during the selection process the history, policy, rules, and regulations of the company are explained orally or given in a printed form. Talks on loyalty, discipline, safety, and other personnel activities are given at that time. Many companies have issued employee handbooks which give information concerning such things as hours of work, wage payment plans, vacations, attendance, and safety.

Table II. Personnel Factors to Be Considered in Selection

Kinds of Factors	*Factors*	*How Determined or Measured*
1. Mental	1. Appropriate intelligence for the job— (1) Alertness (2) Adaptability, etc.	Mental tests, interviews, and ratings
	2. Proper knowledge of job	Trade tests and interviews
	3. Sufficient education and training	Application blank, interview, and references
2. Physical	4. Good health	Physical examination
	5. Fine physique — (1) Height (3) Size (2) Weight (4) Texture	Physical examination
	6. Strength, endurance, speed, and dexterity	Physical examination, strength and special tests
	7. Proper age, sex, color	Interviews and application blank
3. Moral	8. Good character — (1) Honesty (2) Truthfulness, etc.	Ratings, references, and interviews
	9. Supporting habits (no bad habits)	References, ratings, and interviews
4. Social	10. Appropriate personality — (1) Industry	Ratings, interviews, and references
	(2) Good attitude towards work, fellow workers and last position	References and ratings Interviews
	(3) Appropriate appearance	Interviews
	(4) Accuracy, etc.	References, ratings, and tests
	11. Helpful home life, family and community relations and friends	Interviews and references
	12. Wholesome reasons for leaving last position	Interviews and references
	13. Lack of detrimental idiosyncrasies	Interviews, ratings, and references
	14. Convenient location to work	Interviews and application blank
	15. Proper social class for work	Interviews
5. Combination of 1, 2, 3, 4, and others	16. Ability to do the job	Trade tests and tryouts
	17. Relevant experience	Application blank and references
	18. Personal data and experience	Interviews, applications, and references
	19. Proper interests	Tests and interviews

CHAPTER THREE

Personnel Maintenance

AFTER an employee has been hired, he must be promoted, transferred, or maintained on the job. If he does hard work of excellent quality and quantity, performs more and better work than is required, has exceptional knowledge, ability, and personality for the job ahead, has a good understudy, and is more valuable to the company in the job ahead, he will be promoted if opportunities are available. This promotion may take the form of advancement of wages, responsibility, decreased working time, better working conditions, or increased security.

If he is not doing well in one job, he may be transferred to another. In order to find out how the employee is progressing or to determine his present status for future development, many companies use rating scales. Some develop these scales themselves. A good plan for the development of a scale is to obtain, from the persons who will do the rating, the personal qualities or traits and types of behavior they consider essential to successful performance in that company, tabulate the traits given, and devise a graphic rating scale, consisting of the trait name and its definition, followed by the types of behavior by which the trait is judged, graduated from lowest to highest. Figure 3 is a graphic rating scale developed from the opinions of 406 employers, giving the traits they considered most essential to success after graduation.

IMPROVED MORALE

Rating scales are used in industry to develop the employees' personality, to make comparison between employees, to show the progress of individuals, and to improve the morale of the group. The Du Pont Company rates every employee each year. The employee's supervisor goes over the man's rating with him in a frank discussion where, in many cases, difficulties are ironed out and the man's efficiency is improved. The General Electric Company bases promotion largely upon ratings and finds the use of the rating scale an important management procedure.

In the maintenance of personnel, whether it be rating, regularization of employment, or any other phase of the management of men, the recognition that persons are individually different should be present. Individual differences are always important considerations in managing people. Each person has some good qualities and some bad, but most of them center around the average. These individual differences occur because of inheritance, environment, and ancestral influences, brought about by race, color, family differences, sex, maturity, and training.

These hereditary and environmental influences make differences in human motives and desires. People have physical, mental, moral, and social needs, which motivate them to satisfy their desires. For example, they want to eat when hungry, drink when thirsty, secure more air when it is inadequate, secure rest when tired, sleep when drowsy, secure warmth when cold, to escape when frightened, and to be relieved when in pain. These desires cause a man to satisfy his needs by collecting and hoarding, by fighting, by interfering with and overcoming resistance, by securing approval of others, by being a member of a group. Needs and desires are also greatly influenced by the group. Each person gratifies his desires or adjusts himself to them by such means as defense or

DEFINITIONS OF TERMS USED

INFERIOR	Exceptionally poor in performance; exceptionally lacking in the qualifications considered.
UNSATISFACTORY	Work *not* performed as well as should be reasonably expected, not entirely satisfactory.
SATISFACTORY	Efficient; work well performed; up to standard.
EXCELLENT	Work performed in a *highly efficient* manner; qualification better than usually accepted as satisfactory.
SUPERIOR	Pre-eminently efficient in performance; qualified to a pre-eminent degree.

NAME
RATED BY
DATE
DEP'T
RATING

QUALIFICATION RATING

Place a check mark (✓) on the scale for each of the qualifications given, following the above definitions in determining its proper position.

	Inferior	Unsatisf'ry	Satisfactory	Excellent	Superior
JUDGMENT AND COMMON SENSE The ability to think clearly and arrive at logical conclusions. Is he open-minded? Does he exaggerate? Is he prejudiced?	1 2 3 4	5 6 7 8	9 10 11 12	13 14 15 16	17 18 19 20
LEADERSHIP Capacity to direct, control, and influence others in definite lines of action. Is he convincing?	1 2 3	4 5 6	7 8 9	10 11 12	13 14 15
INITIATIVE The trait of beginning needed work or taking appropriate action on his own responsibility in the absence of others.	1 2 3	4 5 6	7 8 9	10 11 12	13 14 15
INTELLIGENCE The ability to understand readily new ideas or instructions.	1 2	3 4	5 6	7 8	9 10
TACT The faculty of being considerate and sensible in dealing with others. Is he co-operative? Is he courteous, respectful, friendly, yet not too cordial?	1 2	3 4	5 6	7 8	9 10
PHYSICAL BEARING AND NEATNESS Dignity of demeanor. Neat and clean in appearance. Is he poised? Is he dignified?	1 2	3 4	5 6	7 8	9 10
FORCE The faculty of carrying out with energy and resolution, that which on examination is believed to be reasonable and right.	1 2	3 4	5 6	7 8	9 10
ATTENTION TO WORK The trait of working thoroughly and conscientiously. Is he steady? Is he easily excited? Is he consistently or spasmodically intense in his work?	1 2	3 4	5 6	7 8	9 10

5460 2-36 1M CARNEGIE-ILLINOIS STEEL CORPORATION

FIGURE 3. Rating scales indicate how the employee is progressing. Some companies rate every employee each year, base promotions largely upon the results

escape mechanisms. Most persons have some thwarted desires or personality defects which if handled sympathetically and expertly can often be removed by removing or exposing the cause. A positive attitude or the substitution of an aggressive approach may overcome the difficulty.

ALWAYS A REASON

One can usually handle people better if he realizes that there is always a reason for a man's acting as he does and that usually this reason can be discovered and corrected. Probably the greatest principle of handling people is the recognition that men are feeling individuals as well as thinking individuals.

Laird[5] investigated the reasons why we don't like people and gave the ten most important ones in the form of the following questions:

1. Can you always be depended upon to do what you say you will?
2. Do you go out of your way cheerfully to help others?
3. Do you avoid exaggeration in all your statements?
4. Do you avoid being sarcastic?
5. Do you refrain from showing off how much you know?
6. Do you feel inferior to most of your associates?
7. Do you refrain from bossing people not employed by you?
8. Do you keep from reprimanding people who do things that displease you?
9. Do you avoid making fun of others behind their backs?
10. Do you keep from domineering others?

Webb and Morgan[6] analyzed the strategy that famous men used in handling people. After reading this I endeavored to put down the principal strategies used, as follows:

1. Be careful of details in dealing with people.
2. Assist outstanding leaders.
3. Emphasize the superior qualities of those who resent you.
4. Make it easy for others to cancel their obligations to you.
5. Make your affairs of personal interest to those with whom you deal. Learn other persons' hobbies and be interested in them. Be posted about others before meeting them, and respect their customs.
6. Approach others through their own experience and needs.
7. Let the other fellow do the talking about himself, (or rather make him do it and show his thoughts first).
8. Try to induce others to participate in your plans. Ask others for advice about them. Consider others important in your affairs.
9. Peoples' wants are different. Make appeals in different ways. Anticipate their wants.
10. Always work for "yes" answers. Word questions to require answer of "yes." Don't argue. Yield to small issues to save large ones. If the main issue is in doubt, delay it. Give as many persons as possible opportunity to air grievances.
11. In disappointing someone shield his vanity and play on his ego. Make listeners feel clever, that others esteem them.
12. Make your cause more important than personal interests.
13. Share the limelight with subordinates. Give them more credit than due them. Help shoulder their mistakes.
14. Learn why others do things (off guard). Strutting and boasting often means some inferiority. Discount first impression.
15. A pleasing personality results usually from a deep and sincere interest in and liking for other people and their interests.
16. Repeat verbally what others desire. Write it if possible.
17. Compliment others in the way that pleases them. Indirect compliments are usually excellent.
18. Establish a reputation in a certain field or of a certain kind as well as in honesty. Be especially modest about things done, yet plan for promotion and self-advancement when time arises by gaining the attention of the right person.
19. Break a rule if it is honest, safe, wise, and protects superiors.
20. Show people things or plans that they can see with their own eyes and in a way that they can see and understand them easily in light of their own experience.
21. Guard all secrets and confidences closely. Learn to conceal thoughts and feelings to others. Start the other fellow talking by asking questions when you do not wish to talk.
22. Make people laugh by the right kind of humor. Make the joke on yourself or an imaginary person.
23. Do not argue with an angry person; to keep silent and ignore him is better. Keep calm when others are losing their heads.
24. If others impose beyond reasonable limits, fight.

NEED FOR PERSONAL RECORDS

Besides the methods of maintaining personnel previously mentioned, an employee likes to know that what he does and accomplishes is known and is made a matter of record. If a record is kept, the employee as a rule will have a better attitude toward higher accomplishment and a greater dislike for misbehavior. This warrants the maintenance of a *personal record* of each employee. This record should contain, as a minimum, the employee's name and address, date and place of birth, nationality, color, marital status, previous experience, education, health record, training, personal references and ratings, name of person to notify in case of emergenccy, service record, remarks, and other pertinent information regarding the employee.

[5] D. A. Laird, *Why We Don't Like People.* New York: The Mohawk Press. 1931.

[6] *Strategy in Handling People,* E. T. Webb and J. J. B. Morgan, Chicago: Boulton, Pierce & Co., 1930.

CHAPTER FOUR

Training and Education

MOST PEOPLE in industry want to know how to do their work excellently and to have a thorough knowledge of, and training in, that work. Industry is coming to realize that training and education of its employees are essential to the highest efficiency. This education involves training on the job, apprenticeship, foreman training, industrial and general courses, training of high school and college graduates, and provisions for a company library or reading room.

When a man is introduced to the job, he should be trained by the management in that job. If he is experienced, that training will be less, but there is always something new about a new job whether it is the same type of work the man had previously performed or not. This training is usually done by the foreman or by an instructor whose sole job it is to train new employees. It may be that the person is entirely inexperienced, which may necessitate an apprenticeship, whereby a regular program of training is provided to make the novice into an experienced worker. Oftentimes these inexperienced men are put on as helpers to experienced workers and help them until the job is learned. After they have learned how to perform the job and pass certain examinations or tests, they are rated as regular machinists, toolmakers, etc. Some workers are trained in vestibules or separate rooms on separate machines from those in production. Then, when they are found to know how to do their job, they are put on production.

What might be considered the next higher level of training is foremanship training, which involves courses, conferences, or discussions of the work that the foreman performs. A general conception of subjects taught in the foremanship training courses may be gathered from the programs of various companies. A course at The Amer-

Apprentice die makers at the Murray Corporation of America which is one of the 74 companies participating in the training program sponsored by the Employers' Association of Detroit

ican Rolling Mill Company, for example,[7] covered: (1) Introduction; (2) history of the company; (3) incentives; (4) opportunity for advancement; (5) living and working conditions; (6) quality and service; (7) ethics in business; and (8) application of Armco policy.

OTHER TRAINING PLANS

The Douglas Aircraft Company divided its foreman training program[8] into the following headings: (1) Exploration and planning; (2) cooperation; (3) cooperation between departments; (4) quality; (5) waste; (6) interest in the job; (7) solving problems by conference. The Studebaker Corporation asked foremen what they really needed in the way of training, and what difficulties and problems they were faced with, and then based its foremanship training upon the replies. Western Electric Company interviewed a large number of employees to determine their attitude and feeling towards their foremen. From the difficulties and problems indicated, the company devised an excellent training program.

Many industries visit high schools and colleges and employ their graduates and train them. High school graduates are sometimes trained for foremanship and specialized work, and college graduates for executive work. The training program for college graduates usually involves from about six months to two years, during which time the graduates progress through a series of work stations or departments where they secure all the pertinent information relative to the varied work and different departments of the company. This is often supplemented by reading and study.

In some of the larger corporations they may be assigned to different plants as well as different departments for a program of work. In some of the companies these men just observe the duties of the different departments, especially for sales training, while in others they actually do the work. Graduates may also be placed on testing various types of equipment manufactured, as exemplified by the General Electric Company Test Course. In many of the companies that train college graduates, the outstanding employees who are not college graduates are also selected for the same or a similar training program.

EXECUTIVE TRAINING

In addition to the training of college graduates, some companies have executive training programs involving conferences on and the study of the executives' work. In addition to company training programs, generalized subjects, such as mathematics, English, and generalized courses that are fundamental to the work of the company, such as electricity in electric companies, are offered.

In the Westinghouse Electric & Manufacturing Company a full technical course can be obtained through cooperation with the universities in Pittsburgh. Some companies cooperate with the grammar and high schools and work out educational programs and night classes for their employees. Others ask graduates of high schools and colleges in their own company to give advanced courses to employees.

The Philadelphia Rapid Transit Company asked the employees what they wanted and needed in the way of educational training. From the replies the company developed a training program that the employees wanted and which, incidentally, related more closely to the particular company than the officers of the company had expected. The practice of making a survey of what is wanted and needed seems to be an excellent principle for adapting training and education to the company. Companies are cooperating more than formerly with local schools and colleges for their educational and training work.

GAINING THE ATTENTION

Training from the psychological viewpoint involves certain learning processes. For an employee to learn methods or processes it is necessary that his attention be gained and kept. As attention depends on change in position, strikingness, size, definiteness of form, and repetition, it is important that the teacher take cognizance of these factors in order to keep the worker's attention; for example, keep the idea "moving" by changing the aspects or viewpoint of the thing being learned. Interest is important and is usually obtained by giving information about the thing to be learned.

Upon having the attention there are certain procedures that facilitate learning—namely, mental exercises, frequency and recency of learning, association, intensity of learning, and good effect of learning. Application of these would be that the worker must really exercise his mind on the matter to be learned, do it frequently, not let it be forgotten too soon, associate it with knowledge and material which he has already learned, do it intensely and with as pleasing a result as possible. A worker will usually learn something presented to him in the way in which he is accustomed to thinking about it better than if presented in a way foreign to him. One worker may learn directly to the point while another may take a roundabout mental path to learn the same thing. One may learn better by dealing with objects, another through pictures, and another by reading or words.

The typical worker will learn rapidly at first, followed by a plateau in the curve of learning, and then a rapid rise to expertness. The test of an expert manager or teacher is to bring the pupil beyond the plateau of learning. This can often be accomplished by studying the individual worker and by the establishment of incentives, giving praise and blame, and applying the various other personnel and psychological factors.

The Western Electric Company studied the factors affecting production of a group of workers from 1927 to 1932. These included physical, psychological, and social factors. The

[7] *Factory*, March, 1935.
[8] See above.

effect of the following physical factors were investigated[9]:

1. Changes in the length of the working day.
2. Changes in the number of working days in the week.
3. Working days with and without rest pauses.
4. Frequency of changes in type of relay to be assembled.
5. Changes in the quality of the parts supplied.
6. Number of hours during which the operators were in bed on the previous night.
7. Vacations and holidays, both in anticipation and retrospect.
8. Periodic illnesses of the workers.
9. Daily, weekly, and annual cycles.
10. Changes of temperature and of relative humidity.

The conclusion reached concerning these physical factors was that their effect was slight or negative. The contention of the investigators was that the physiological reserve compensated for physical changes in their physical circumstance.

The effect of character and social relationships of the workers, and of the mental attitude and human relationships, was also investigated. The results investigating the human factors warranted this conclusion:

"In the first place, significant changes in work behavior can almost always be traced to changes in mental attitude rather than to changes in physical circumstance.

"Second, these changes of mental attitude usually, though not always, relate themselves to the workers' human relationships, either as between themselves, or as between the workers and the management.

"And this suggests a rather obvious, but very important, truth—namely, where operators are working well within their physiological possibilities, their work behavior will be conditioned by their work morale. That is, their behavior will depend on the force and the liveliness with which the work situation captures their imagination, and tones their thoughts."

[9] T. N. Whitehead, "The Scientific Study of the Industrial Worker," *Harvard Business Review*. July, 1934, Pages 458–471.

CHAPTER FIVE

Medical and Health Service

HUMAN efficiency is dependent upon good health. Wise management will endeavor to maintain a healthy working force both in body and mind. Health and medical activities in industry attempt not only to prevent unhealthy workers from entering a company, but also to keep them healthy while they are working by the prevention of illness within the plant. Industrial health activities involve (1) physical examination prior to employment and periodically, (2) first aid and dispensation, (3) medical treatment of illness and prevention of contagious disease, (5) hospital, (6) sanitation, (7) special treatments, (8) health education, (9) mental hygiene.

In order to prevent contagious diseases from entering the plant and to guarantee healthy entering workers, a physical examination should be given before the employee is hired. Otherwise someone might be employed who had a contagious disease or with some physical defect that would prevent him from doing his work efficiently. As a result of physical examination, employees are sometimes rated by classifications, such as "A" qualified for any work, "B" qualified for limited work, "C" qualified for work after the correction of certain minor difficulties, and "D" disqualified for work. In the last case the employees would not be hired.

In order to discover health irregularities in employed workers before real difficulties occur, some companies give physical examinations periodically in order to keep the worker in a healthy condition. This is not only for his personal happiness, but also for more effective work.

Often while a man is working he receives certain minor cuts and injuries, which if allowed to go without care until he reaches home, may become infected and cause greater difficulty than if attention were given immediately. Many companies have provided first aid and dispensaries to care for these minor injuries and illnesses. Some companies even provide hospitals, special clinics, plant nursing, home and visiting nursing, and make regular inspections of the plant for cleanliness and sanitation purposes.

Small plants sometimes have local doctors visit the plants at stated hours to take care of health difficulties, or join with other small companies to provide medical activities. Industrial medical service is sometimes given as an example of socialized medical practice at reduced cost to the workers and their families.

ESSENTIALS OF A GOOD PROGRAM

The United States Public Health Service considers the following essential to a good health program:

1. Adequate lighting, with the light distributed properly, free from glare, and yet sufficiently concentrated on the work in hand to prevent eyestrain.
2. An exhaust system to remove deleterious fumes and dust.
3. Abundant drinking water, cold, but not ice-cold, within easy reach.
4. Attractive, quiet rest rooms, especially for women.
5. Lunch rooms or canteens where a hot lunch of nourishing, well-cooked food, selected according to a scientific dietary, may be purchased at cost and eaten amid attractive surroundings.
6. Clean and well-ventilated toilets.
7. Washing facilities, with abundant soap, clean towels, and shower baths where the hot, sweaty, begrimed worker may become cool and clean before leaving the plant.

Rating Scale of Health Activities

Sections and Subdivisions	*Assigned Values*	
A. Death, Sickness and Accident Records	..	15
1. Records Kept	5	
2. Records Used	10	
B. Sickness and Accident Prevention Measures	..	30
3. Investigation of Cases	7	
4. Sanitary Inspections	7	
5. Sanitary Supervision	6	
6. Specific Immunizations	3	
7. Safety Devices	5	
8. Examinations After Sickness	2	
C. Personal Health Promotion	..	40
9. Physical Examinations	10	
10. Periodic Examinations	5	
11. Correction of Defects	2	
12. Health Supervision	3	
13. Supervision of Occupational Injuries	5	
14. Medical Attention	5	
15. Health Education	10	
D. Public Relations	..	15
16. Compliance with Board of Health Regulations	5	
17. Compliance with Federal and State Laws	10	
Maximum Total Score	..	100

FIGURE 4. Use this appraisal form to rate your company's health activities

8. Introduction of variety into work.
9. Introduction of recess periods.
10. Adjustment of speed.
11. Omission of unnecessary motions.
12. Provision for adjustable seats.
13. Ample ventilation of workrooms.
14. Adjustment of hours of work.
15. Avoidance of overtime work.
16. Omission of Sunday work.
17. Sanitary conditions outside the plant.

Dr. L. D. Bristol, Health Director of the American Telephone and Telegraph Company, has devised an appraisal form for industrial health service in smaller industries and business concerns. It is shown in Figure 4.

Credit unions supply employees with a plan for convenient, systematic saving; take care of their short-term borrowing problems

The purpose of all health activities is naturally to make employees more healthy and efficient, not only for their personal enjoyment but also for the work of the company. Specifically, it may be to reduce absences because of sickness. When the usual absence from work because of illness is about seven days, we can appreciate its importance in a company of 1,000 employees. If by health activities that absence because of illness can be reduced to five or six days, it represents a saving to the company of one or two days per employee. The fact that health work pays the company may be one of the chief reasons for it.

CHAPTER SIX

Safety and Accident Prevention

INDUSTRY has given us many comforts, luxuries, and conveniences—railroads, automobiles, airplanes. Yet these creations are not entirely beneficial because they contribute to the accidental deaths of between 70,000 and 90,000 people and over 3,000,000 injuries each year. Besides this human waste, it has been estimated[10] that the average cost to industry, worker, and manager, is about $246 per injury, at a total cost to this country of several billion dollars. This human and financial loss is outrageous when we consider that practically all of it could be prevented if there were a sufficiently strong desire on the part of the people to do so.

The principal factors that are used to prevent accidents are (1) mechanical safeguards, (2) safety education and publicity, (3) safety inspections, safety records, and statistical work, (4) engineering revision and safety engineering, (5) safety competitions, rallies, and parades, (6) fire and police activities.

One of these methods alone may do but little good, but all of them can decrease accidents materially. For example, the Eastman Kodak Company decreased accidents 90 per cent, the Illinois Steel Company 70 per cent, the Bucyrus Company 65 per cent, and so on, showing that it can be done by these means.

It has been estimated that mechanical guards placed upon the machine so that the worker cannot injure himself can prevent only about 10 per cent of the accidents that occur in industry. The psychological and physical factors in accident prevention are extremely important.

Nevertheless, every machine should be mechanically safe to the extent of *positive* safety if possible. Positive safety means that the worker cannot operate the machine unless he is safe from injury. For example, in operating a punch press the worker's hands must be up and away from the dangerous parts when he grasps the starting levers. Positive safety can usually be accomplished by so placing the starting levers that the worker's hands or other parts of his body are safe before he can start the machine. This may decrease production on the machine, but one of the jobs of the manager or his engineer is to make machines positively safe without decreasing production. Usually it can be done.

NINE OUT OF TEN

Probably the greatest number of accidents can be prevented by safety education, publicity, and other safety activities. It has been estimated that 90 per cent of the preventable accidents can be prevented by these means. They involve appointing of safety committees, holding safety conferences and discussions, exhibiting of safety posters, having regular periodical safety inspection, preparing safety statistics about accidents and publicizing them, holding safety competitions between departments and plants, safeguarding the plant from the standpoint of fire, protecting the plant by police activities, and engineering revision and safety engineering.

In practically all states it is necessary to prevent accidents because the employer is legally liable for accidents in his plant. Under the Workmen's Compensation Acts the employee is compensated for accidents arising during his employment. This usually involves the reimbursement of one-half to two-thirds of the weekly salary with a stated maximum and minimum amount payable. In case of death, a fixed sum is paid to dependents by the employer. For the loss of a finger, arm, or other member of the body a fixed sum is usually paid. For total disability there may be a lump sum or payment of a percentage of the worker's wages periodically. Many companies cover their accidents and liabilities through compensation insurance with established companies. The premiums are calculated actuarially and based partly upon the number of accidents which occur. The lower the number of accidents, the lower will be the premiums. Therefore, it pays from a dollar and cents viewpoint to prevent accidents as well as from the predominant human reason of saving life and preventing suffering.

[10] H. W. Heinrich, "Industrial Accidents and Safety", *Monthly Labor Review*. November, 1930.

CHAPTER SEVEN

Personnel Service Work

PERSONNEL service work originally took the form of welfare work, but the old welfare work became so paternalistic and charitable in recent years that it has developed into a more strictly business proposition and has taken over many of the extra financial benefits to employees which are often organized and managed by employees themselves or in cooperation with the management.

Many companies maintain mutual benefit associations. In these associations, employees pay small fees each week or month which are sometimes added to by the employer. The resulting funds are used to pay accident, sick, and death benefits to the employees.

In recent years unemployment benefits and insurance plans and pensions have received considerable attention. The Social Security Act has also emphasized this phase of personnel service work. Everyone is always interested in what will happen if he should lose his job or become too old to work.

DISMISSAL WAGES

Closely related to unemployment insurance is dismissal compensation. The Industrial Relations Section of Princeton University made a study[11] of dismissal compensation plans in 80 companies of 27 cities.

In 60 companies, 35 paid lump sum dismissal compensation, 13 paid periodic installments, and 12 paid by means of combinations of these two. In 40 companies, 29 charged the dismissal wage to wages, production, other costs of the departments or units, 9 to special dismissal accounts or funds, 1 to the hiring office, 1 to general expense.

The field of dismissal compensation is an activity which is distinctive of the depression beginning in 1929, and shows a change in attitude of employers toward keeping employees as long as possible, and when it is necessary to let them go to provide in some way for them to bear the burden of unemployment.

It is the belief of some employers that an employee provided with security for his old age (after he has given his best years to the company) is a more efficient worker. This belief coupled with the desire to provide humanely for aged employees in a business-like manner has led to the establishment of pension plans in industry.

The Industrial Relations Counselors made a study of industrial pension plans during the period from July 1, 1929, to April 3, 1932. Sixty-nine industrial pension plans, (4 non-contributory, 62 contributory, and 3 composites), were established during that period. The trend was found to be from non-contributory toward contributory plans, 12 companies with non-contributory plans having changed over to contributory ones.

Forty-five pension systems (28 non-contributory, 17 contributory), were discontinued or suspended during the period. Both establishment and discontinuance of pension plans were large during the period, but fewer were discontinued than established, so there was a net gain in the number of plans.

GUARANTEED PENSIONS

The 434 companies reporting on their pension systems were estimated as having built up $625,000,000 reserves. All of the 69 companies with new plans guaranteed the pension as soon as it was granted, and in 68 the guarantees are made by insurance companies.

Employees will, it was reported, support pension plans more wholeheartedly if deposits are returned with interest in case of withdrawal, if the pensions are guaranteed, and if a stipulation is made that funds paid in shall not in any case revert back to the employer. Employees also favor a benefit for total or permanent disability, a gradation of contributions according to age at entry, and a provision for optional annuity forms at retirement.

GROUP INSURANCE

In the last two decades and even during the depression beginning in 1929 another kind of insurance—group insurance—has grown rapidly. In this plan the employees of the company, as a group, take out life insurance. The company deducts the premiums from their pay, and sometimes the company itself pays the whole or part of the premium. By the group method, the insurance premium is much lower than the regular individual commercial rate. All the employees are covered without physical examination at the time the insurance is taken out, but 75 per cent of the employees must participate. The old employees, as well as the young, are covered. This gives those employees an opportunity to be protected who would normally not be able to obtain insurance commercially. In the past, premiums were practically all paid for by the employer alone, but almost all of the newer plans are on a contributory basis.

If an employee becomes sick or has some other difficulty that makes it necessary for him to have a loan and if he has no insurance against sickness nor money saved, he may have to go to the money lenders and pay a high rate of interest if the company does not have a loan plan for employees.

Many companies have credit unions which have enjoyed a healthy existence even during the recent depression. A credit union is a cooperative association organized under a state or the federal credit union law within a specific group of people for the purpose of supplying the members of that group with a plan of systematic saving and of taking care of their own credit or borrowing problems at a legitimate rate.[12] The members of the group operate and control the credit union themselves.

STOCK OWNERSHIP

In opposition to group insurance, credit unions, and the other personnel activities that increased during the depression are those that had difficulty. Employee stock ownership plans, whereby the employees are permitted to purchase the stock of the company, probably had the greatest difficulty.

The Industrial Relations Section of Princeton University investigated the effect of the depression upon employee stock ownership in fifty selected companies.[13] The general conclusion drawn was that few employee stock purchase plans have been successful. Of the 50 plans studied, 31 had been given up or suspended at the time the study was made. This was due, in a large extent, to the falling prices of the securities sold to the employees and the reduction in employee incomes.

Thirty of the 50 plans provided for a cancellation of the subscription upon the request of the employee. Other measures taken to protect the employees were the suspension of payments for stock in lay-off or part-time work, loans to employees on stock as collateral, and a guarantee of the return of the purchase price.

LIMITED TO EXECUTIVES

An important trend was found to be toward plans limited to selective groups of executive employees. Fifteen of the plans were limited to higher paid or executive groups, and eight of these were established fairly recently.

In most personnel service activities it has been found that employee management of them provides for a better cooperation and participation in those activities by the employees, the greater number of employees participating the better.

---

[11] Princeton University, Industrial Relations Section. *Dismissal Compensation Plans in 80 Companies.* Princeton, 1932.

[12] For a discussion of credit unions and their recent developments, see R. C. Bergengren, *CUNA Emerges,* Madison, Wisconsin: Credit Union National Association. 1935.

[13] Princeton University, Industrial Relations Section. *Employee Stock Ownership and the Depression,* by Eleanor Davis, Princeton: 1933. *As reported in the Monthly Labor Review,* Vol. 37, No. 2, August, 1933. P. 279.

★ ★ ★ ★ ★ ★ ★ ★

esses to make their products better and at lower costs. Results have amply proved the wisdom of their action.

Other industries, more conservative perhaps, have held back in the consideration of new equipment. "Don't buy those new machines yet, we'll get along somehow," Management says to the Production Department. And instead of sharing the benefits of progress, it "gets along somehow," perhaps into a serious and even critical situation, costly and difficult to remedy.

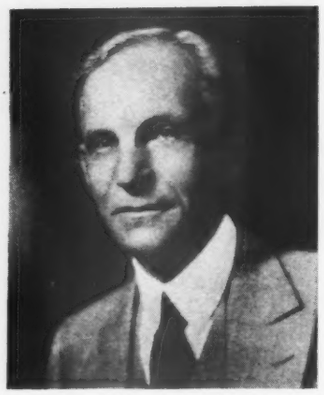
Machine tools advance with the needs of industry, and the industries which make best use of modern machine tools today are in the forefront... making better products at lower costs, selling more, creating employment, helping to advance the American standard of living.

Their courage and foresight are keeping the machine builders' shops busy, and we are proud to ally our forces with theirs in carrying the increased load.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION

Cleveland, Ohio

FORD AND HIS FIGHT FOR INDUSTRIAL JUSTICE



"WE ARE LIVING in a great transitional period!" — how often have we heard that expression.

Some hear it or say it with awe or foreboding — as if transition were a reversal of Progress which will bring Society something less desirable than what we have today.

But very few accept the view that change means loss. All one has to do is to compare the strides of Human Progress during the last 50 years with those made in all the ages before. Human Progress is not petering out. It is accelerating, organizing itself, getting adjusted for unprecedented advances.

The coming New Era will have certain outstanding characteristics. What will they be?

There will be many of them — improvements along many different lines, some of them seen but dimly as yet; but the MOST OUTSTANDING CHANGE OF ALL will be a BETTER SOCIAL BALANCE, a nearer approach to SOCIAL AND INDUSTRIAL JUSTICE.

What is the evidence of this?

HERE IN THE UNITED STATES the ground has already been made ready by successful demonstration. American standards of living, American customs, methods and practices are no longer ideals, enshrined in words; they have been made concrete by PRACTICAL EXAMPLE — and this American economic example is already having a deeper and more far-reaching influence on the rest of the world than anything this Nation heretofore has done.

How was the ground made ready in OUR COUNTRY?

By the vision, thought, effort, courage and determination of an unbroken line of men, one or more of whom rise with each generation, and whose work benefits billions of fellow-beings, the whole world around. Humanity benefits from the work of these individuals, because each in his way brings forth new things which ultimately result in:

1: A vastly wider CREATION and DISTRIBUTION OF THE WEALTH OF THE EARTH, and

2: An incalculable EASING of the TOIL OF LABOR.

Who were some of these men?

There have been scores of them, but the names of four will suffice: Kelly, whose carbonizing process gave the world cheap steel; Bell, whose telephone gave humanity quick communication; Edison, who brought to the service of millions the light and power of the electric current; and Ford, who has given to millions, the world over, fast, dependable transportation.

While Ford has lightened incalculably the labor of the world, put power and transportation at the disposal of every family and distributed wealth to the common man as has no other individual in history, his greatest service has been in RAISING THE AMERICAN STANDARD OF LIVING. He was born into a world in which $2 for 12 hours' work was a high industrial wage, and in which the horse and buggy gave the wealthier American family a range of from 12 to 25 miles from home.

Ford instituted and pays, on a grand scale, the highest industrial wages in the world; operates on an 8-hour basis; has practiced the 5-day week for years, and given 24,000,000 families the means of RANGING THE CONTINENT at will.

For many years, his efforts to accomplish these and other ends beneficial to the average American have met the unremitting opposition of reactionaries in finance and industry generally, who did not share his sympathies or have his vision. He has labored to help them to see that decent working conditions and high wages are not only good business but are evidence of COMPETENT MANAGEMENT.

Ford came honestly by his instincts to do this. For many years he was a working-man and a wage-earner. He toiled and struggled with all the obstacles that beset men. And it was only natural, from his experience, that, in the end, he should want the automobile to be easily attainable by the people who make them, and an enjoyable adjunct of every working-man's home.

It was this bond between Ford and the toiler that terminated his first business venture. His associates wished to keep the motor car the exclusive luxury of well-to-do families. Ford wanted to build a low-price car that the working-man could own. He would not yield. He broke with his associates on that principle.

Then he founded the Ford Motor Company. But opposing interests tried to force him into an association under which he must pay a "license" to manufacture; just another method of keeping production low and prices high. All other manufacturers had gone in. Ford fought it single-handed, and, in the end, after nine years of litigation, won.

At a time when it was deemed the essence of sound business to employ as few men as possible, work them as long hours as possible and pay them as little as possible, Ford launched, on a huge scale, a policy of employing as many men as possible, on the basis of a shorter day and shorter week, and yet paying higher and higher wages. Over the years, his basic $5 minimum wage advanced to $6, then $7. Only world-depression made it recede. It stands at $6 today. Over the years, Ford's basic wage has tended constantly to raise the wages of labor in every other field.

Constantly, Ford's mind works to make more jobs and to lighten the load of the working-man. He does both by constantly scrapping old and obsolete machines and introducing more new and better ones.

Thirty-three years of Ford manufacturing and industrial experience prove that the machine does not destroy jobs — it makes more of them. One year, when the company spent $4,000,000 for machinery, the number of its employees increased by 20,000 and the payroll by $48,000,000. In another year, when the company spent $9,000,000 for machinery, the number of its employees increased by 40,000 and its payroll by $88,000,000.

The more machinery the more men — that has been Ford's experience. He himself always speaks of labor-SERVING machinery; never of labor-saving machinery. He finds that the machine may shift labor but not dispense with it.

Economists say that the basic reason why the standard of living of the American working-man is higher than that of the working-man of any other country is not only because of the abundance of this country's natural resources, but because American Industry has put more mechanical power at the disposal of the average American working-man than is available to the average worker of any other land.

Statistics show that the average worker in France has available for his use 1.78 H. P.; in Italy, 2.14 H. P.; in Canada, 2.17 H. P.; in Great Britain, 2.56 H. P., and in the United States, 4.86 H. P.

The average Ford working-man has at his disposal, for his use, in making his living and gaining for himself and his family the comforts and many of the luxuries of life, 13.5 H. P.

The average cost to the Ford Motor Company of setting up a job for an employee to work at is $9007.

Does Ford find it profitable to operate on this basis?

Assuredly!

But by far the greater part of the profit is PASSED ON TO THE PUBLIC in the GREATER VALUE in REAL WEALTH expressed in THE FORD CAR.

For example: The Ford Motor Company has received, in the 32½ years it has been in business, up to January 1, this year, the sum of $12,848,000,000.

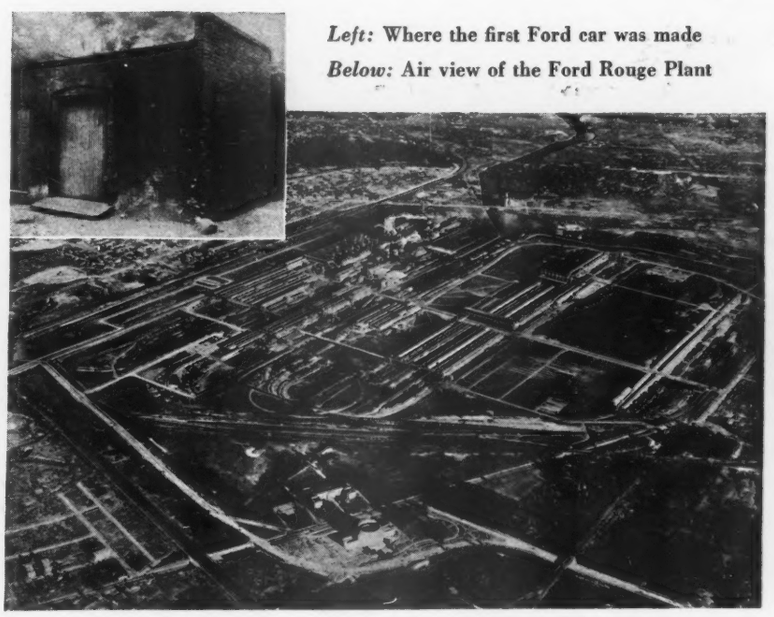
Of this INCOME, the vast bulk — 93.73 per cent — IMMEDIATELY BECAME OUTGO. For WAGES AND MATERIALS over that period, the company paid out $11,466,000,000. For TAXES — City, County, State and Federal — it paid out $576,416,000. That makes a total of $12,042,000,000 PAID OUT.

Ford has used the remainder in maintaining, operating and expanding his industry. With it he has built branches in 52 American cities.

The greatest MATERIAL PROFIT created by the Ford industry goes to the PUBLIC in the OWNERSHIP, UTILITY and SERVICE OF THE FORD CAR.

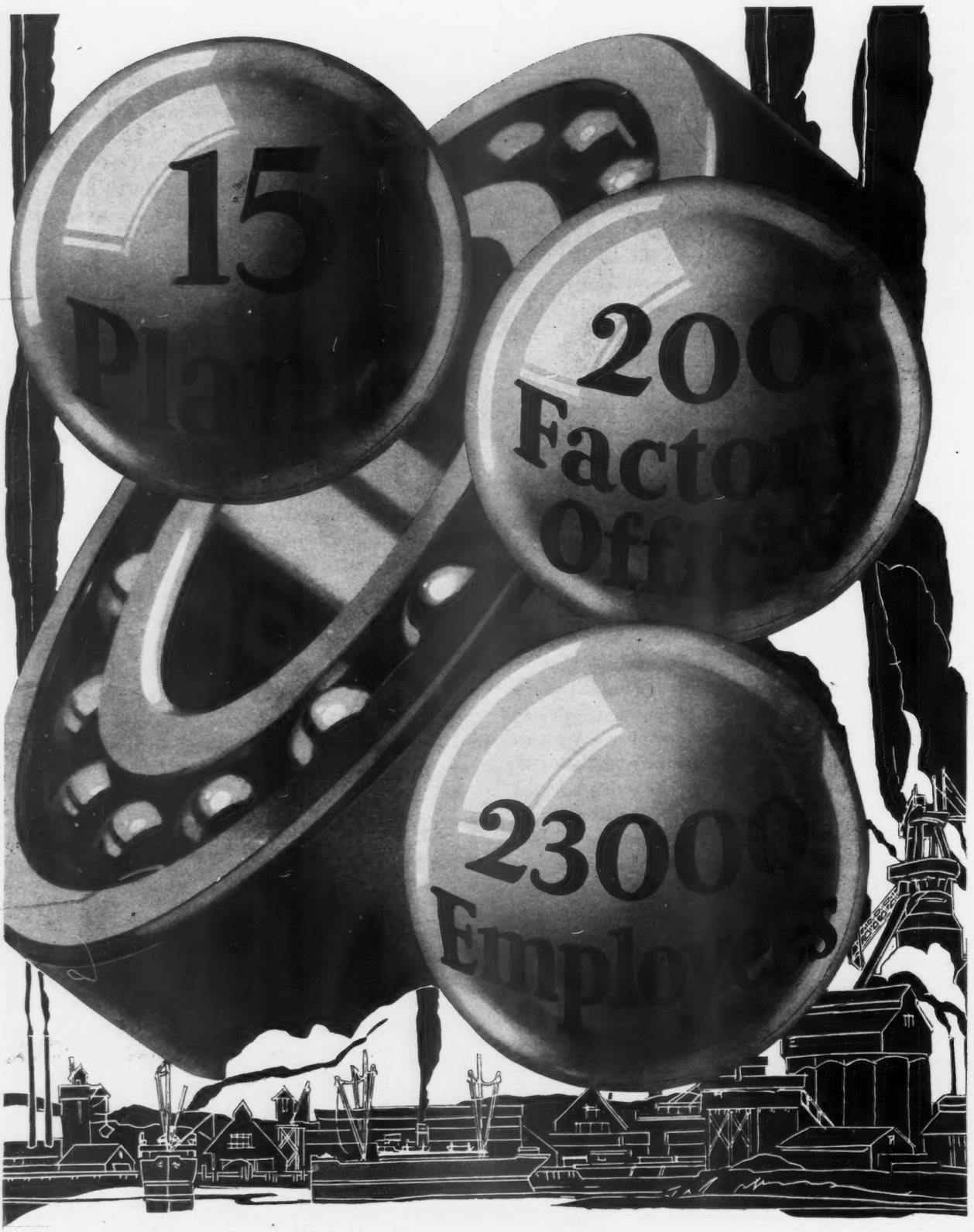
But the GREATEST PROFIT OF ALL is the HUMAN PROFIT, spread by means of the HIGHER STANDARD OF LIVING and the EDUCATIONAL AND CULTURAL OPPORTUNITIES which the Ford dollar, directly and indirectly, brings to MILLIONS OF AMERICANS, workers and customers alike.

FORD MOTOR COMPANY
DEARBORN MICHIGAN



Left: Where the first Ford car was made
Below: Air view of the Ford Rouge Plant

Copyright 1936, James V. Piersol, Detroit News



SKF

DAYTON COG-BELTS CUSHION THE SHOCK

THEY START AND RUN SMOOTHLY

Dayton Cog-Belts prevent damage to machines and tools. In many cases, these belts save thousands of dollars per year by cutting down repair bills. This is because Dayton Cog-Belts have greater shock-absorbing ability due to their automatic wedging action in the pulley grooves. They avoid starting and running shocks. They eliminate jerks and back-lashes.

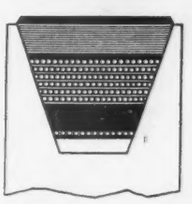
They are the only laminated belts scientifically "built-to-bend." They are the only die-cut belts with raw edges which give leech-like gripping qualities that insure a steady, uniform flow of power with less tension and less strain on bearings.

But get all the facts by asking for a copy of our big new book, "The A B C's of V-Belts." It graphically illustrates and clearly explains the many advantages of Dayton Cog-Belt Drives. Write for your copy today.

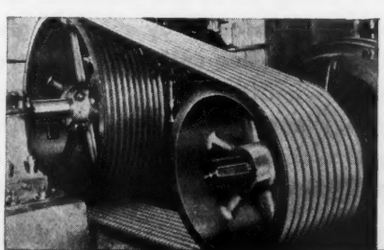
THE DAYTON RUBBER MFG. CO.
DAYTON, OHIO

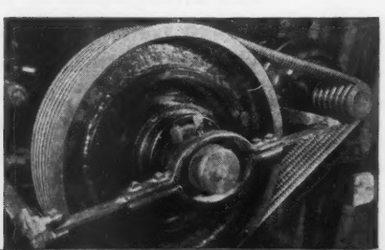
World's Largest Manufacturers of V-Belts
Manufacturers also of Dayton Fan Belts, Dayton Red Tube Radiator Hose, Dayton Thorobred Tires and Dayco Printers' Rollers

HERE'S WHY



When machines are started, or when peak loads come on, the Dayton Cog-Belt smoothly wedges itself automatically into a tighter grip in the groove—and cushions the shock.





COMPACT • DURABLE • EFFICIENT

Dayton

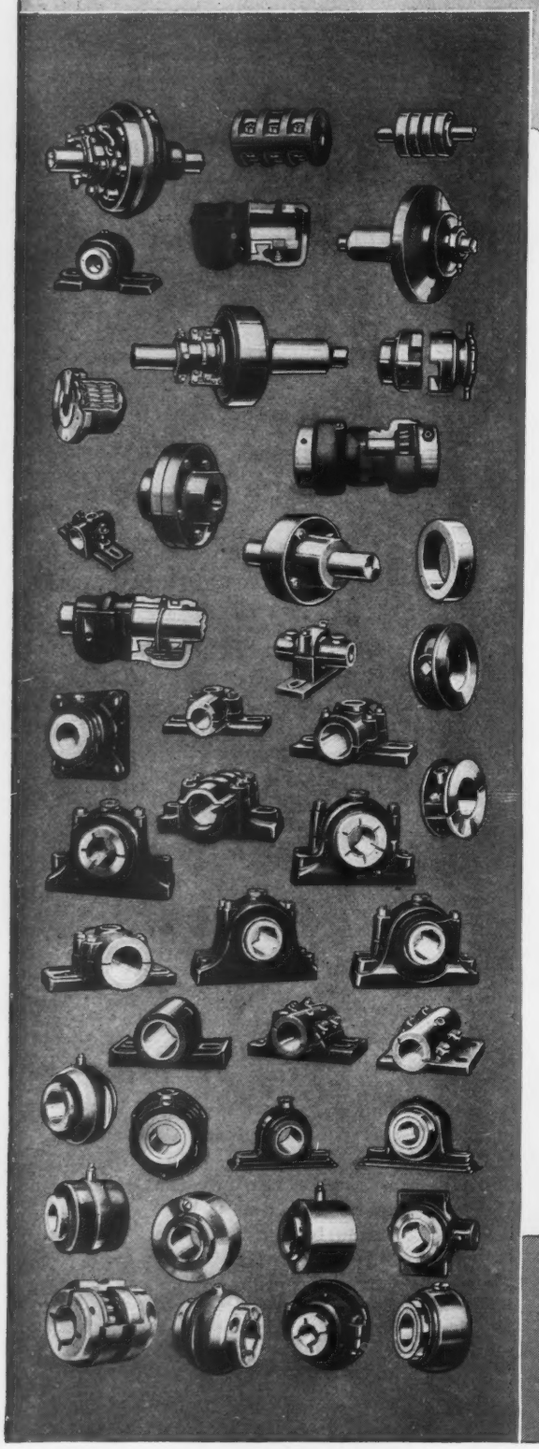
COG-BELT DRIVES

COG-BELT DRIVES—F. H. P. V-BELT DRIVES—V-FLAT DRIVES—DAYCOIL OIL-PROOF V-BELTS—COMPLETE DRIVES, PULLEYS and BELTS IN STOCK

THE A B C's OF V-BELTS

This is the greatest book on V-Belts ever published. It shows how Dayton Cog-Belts transmit more power, save space, last longer, and reduce costs. This important book will help you solve your drive problems. It's free. Write for a copy.

Dependable PO
CONTRO



This Completely Enclosed Clutch is Rugged, Safe, and Positive in Action

Dodge has answered the industrial demand for dependable, safe, low-cost power transmission with the Dodge Diamond "D" Clutch. High performance quality is achieved through precision manufacture and special design features—guaranteeing dependable operation and long life under the most severe service conditions . . . For instance, dependability is insured in the Dodge Diamond "D" Clutch with the unit fully enclosed to exclude all dust or dirt . . . proper proportioning and accurate balance permit high speed operation . . . ample safety factor to handle up to 100% overload . . . *All of the power goes through a Dodge Diamond "D" Clutch!* Full rated horsepower is developed with large friction areas. Powerful self-locking toggles allow easy and positive engagement and disengagement. All working parts are precision machined from high-grade, heat-treated alloy steel to give you a more rugged and longer-lasting unit . . . For power transmission or machine application there is a Dodge Clutch for every industrial purpose — with each unit backed by a half century of successful Dodge experience in building power drive units. Next time — specify DODGE!

DODGE MFG. CORPORATION, Mishawaka, Indiana, U.S.A.

DODGE
MISHAWAKA

These features mean added value

Compact—Dimensions have been kept within practical limits required to transmit rated horsepower.

Horsepower Rating—Clutches are rated to allow 100% overload.

Friction Surface—Large friction area develops the full rated horsepower under practical unit pressure.

Friction Material — Asbestos discs with ground faces insure full friction contact.

Completely Enclosed — In both engaged and disengaged positions, clutch is completely enclosed, insuring safety to workmen and full protection against dust and dirt.

Easy Adjustment — One point adjustment is simple, positive and convenient.

Slip Ring—Heavy duty construction — small — easy to lubricate. Either bronze or ball bearing.

Throw—Movement of slip ring is constant and is not affected by wear of friction material or adjustment of clutch.

Operation—Powerful self-locking toggle mechanism allows easy and positive engagement and disengagement.

Precision Manufacture—Close tolerances insure accurate assembly, true running balance, uniform throw, easy adjustment and complete interchangeability of parts.

Copyright 1936, D. M. Corp.

THE *Right* DRIVE FOR EVERY JOB

There is Added Value In the Name Dodge

INDUSTRIAL
Fractional Horse Power
POLYPHASE MOTORS

1/6 1/4 1/3 1/2 3/4

Meet Rigid Industrial Demands

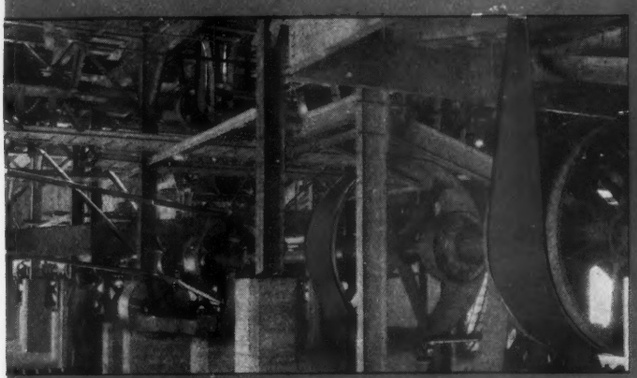
Definitely designed and built to meet the most rigid *industrial* requirements and the exacting demands of heavy-duty continuous precision production—these fractional horse power Century Polyphase Motors fully measure up to every performance requirement of the tools and equipment they drive.

Quiet starting—Quiet running—Remarkable freedom from vibration—Harmonizing appearance—Built throughout to precision standards.

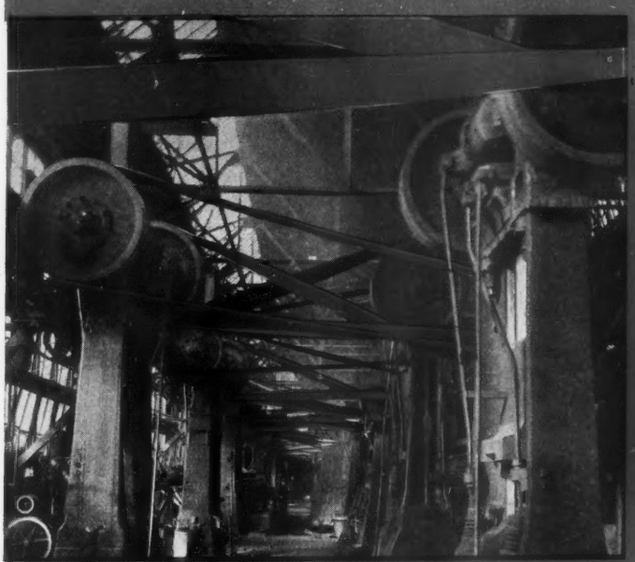
CENTURY ELECTRIC COMPANY
1806 Pine Street • • • St. Louis, Mo.
Offices and Stock Points in Principal Cities

SIZES UP TO Century MOTORS 600 HORSE POWER

In a coal mine



In a hardwood lumber mill—on a main pulley shaft



In a steel mill

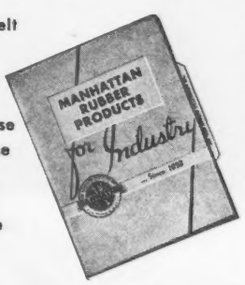
Condor
TRADE MARK REGISTERED
Compensated
PATENTED

THE LOW TENSION RUBBER BELT for INDUSTRIAL DRIVES

Used on the varying types of drives throughout industry. Condor Compensated is the low tension rubber belt with equalized ply stresses over pulleys. It has amply demonstrated its efficiency, economy and dependability . . . Twelve outstanding advantages over standard rubber belting cause a rapidly growing number of manufacturers who are determined to get maximum operating economy to specify Condor Compensated. It handles peak loads with minimum slip, holds fasteners three to four times longer and does not stretch nor shrink. Plies do not rupture because they are equalized . . . The installations shown are typical of the difficult service drives on which Condor Compensated Belt performs with record efficiency.

Condor
PRODUCTS

Transmission Belt
V-Belt
Conveyor Belt
Air Hose
Contractors Hose
Sand Blast Hose
Suction Hose
Fire Hose
Hydraulic Hose
Steam Hose



Water Hose
Chute Lining
Launder Lining
Industrial Brake Blocks and Lining
Molded Rubber Goods
Rubber Lined Tanks
Rubber Covered Rolls

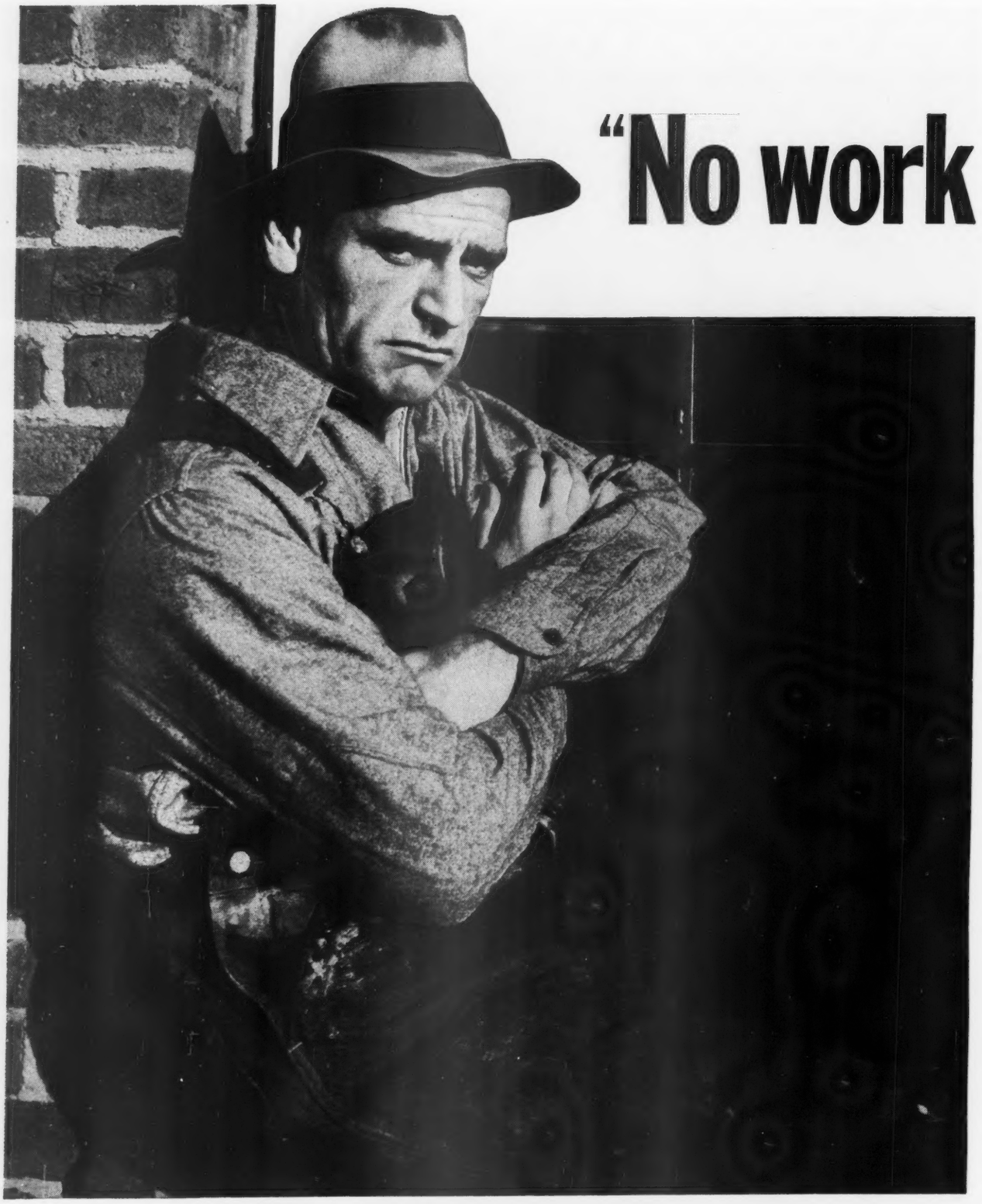
Rubber Bonded Abrasive Wheels

Write for New Catalog

THE MANHATTAN RUBBER MFG. DIVISION

OF RAYBESTOS-MANHATTAN, INC.

EXECUTIVE OFFICES and FACTORIES, 33 TOWNSEND ST., PASSAIC, N. J.



"No work

ANACONDA
from mine to consumer
36448 REG. U.S. PAT. OFF.

Anaconda Wire &

General Offices: 25 Broadway, N. Y. • Chicago Office: 25 North Wacker Drive

today...the feeder blew"

Modernize those obsolete, deficient electric circuits now! One breakdown may cost thousands in interrupted production. Let us send you a free check chart with which to make a Wiring Survey of your plant

To many manufacturers, speed-ups in production are proving dangerous. Undersized or antiquated cables can't stand the strain. A typical example: a main feeder blew, crippling production in one department. Other departments dependent upon the first one were forced to stop. Result: practically a complete shut-down for twenty-four hours! All because management had failed to modernize wiring!

9 out of 10 factories have deficient wiring—Estimates show that 9 out of 10 plants today are handicapped by antiquated electric circuits. Even when actual breakdowns do not occur, money is being lost in other ways. Power wasted through heat losses is one. Excessive maintenance and repair costs is another. Slowing down of machines due to voltage drops is a third.

Often the losses are *invisible!* They are not billed to the treasurer, yet he pays for them just the same. In every case, the proverbial "stitch in time" would remedy matters.

Check up your factory's electric circuits—Are you getting full use of the power you buy? It will cost you nothing to find out. This Survey is yours for the asking. It will show you how to check your factory's circuits.

Get our Wiring Survey

Write for it—then put the problem up to your electrical engineer, your industrial consultant, or electrical contractor. If you have a specific problem in mind, consult our engineering department. We will cooperate without obligation.

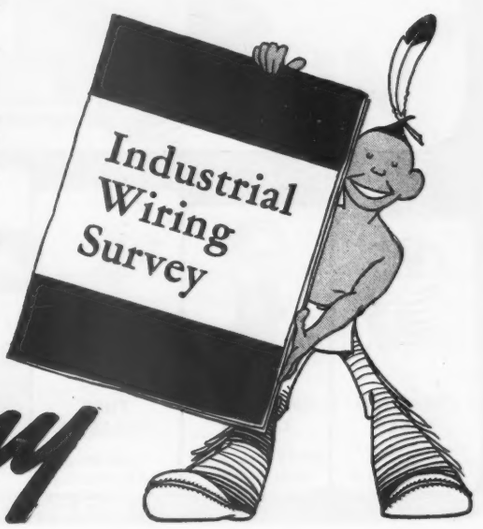
. . .

"In justice to labor... in fairness to capital... modernize the electric wiring in your plant."

Modernized wiring aids plant operation in these 6 ways

1. Prevents breakdowns that retard production and cause labor to lose wages.
2. Prevents light losses and slowing down of machines due to voltage drop.
3. Prevents dissipation of power in form of heat losses.
4. Lowers maintenance and repair costs.
5. Permits shifting of equipment or installation of new machinery with minimum delay.
6. Protects safety of workers and lowers insurance rates.

SEND FOR YOUR COPY



Cable Company

Sales Offices in Principal Cities

TRICO

REG. U S. PAT. OFF.

ONE YEAR and NO FAILURES

WITH TRICO FUSES and KLIPLOK CLAMPS!

A Large Plow Works Writes:

"It's almost a year since we ordered six 400 Amp. TRICO Fuses and clamps for our feeder lines on which we experienced no end of trouble.

We are so well pleased that we are gradually equipping our entire plant with this combination and strongly recommend its use to anyone interested in securing perfect fuse protection."

(name on request)

WARNING:
KLIPLOK CLAMPS are fully protected by U. S. Letters Patent. Infringements will be rigidly prosecuted.

TRICO FUSES are expressly designed to accommodate only the famous TRICO Powder-Packed Renewal Element — **non-interchangeable and tamper-proof**— "Foreign" links will not fit into them.

KLIPLOK CLAMPS stop further unnecessary costly shutdowns caused by poor clip contact. They eliminate burnt clips and fuses—wasted current and premature blowings.

TRY TRICO TODAY!

If your Jobber cannot supply you, write—
TRICO FUSE MFG. CO., Dept. C, Milwaukee, Wis.
In Canada—IRVING SMITH & CO., MONTREAL

COLORTOP FUSES
COLOR TELLS SIZE

OPTO-MATIC OILERS
SAVE OIL AND BEARINGS

FUSE PULLERS
NON-BREAKABLE

RENEWABLE FUSES
WITH
NON-INTERCHANGEABLE, TAMPER-PROOF POWDER-PACKED ELEMENTS

ONE-TIME FUSES
BUILT FOR SERVICE

DRIP-DROP OILERS
SAVE OIL AND BEARINGS

KLIPLOK CLAMPS
SAVE FUSES AND CLIPS

PREFERRED FOR QUALITY

to O.K. your Lighting!

. . . it Takes a Walking Encyclopedia of 288 pages!

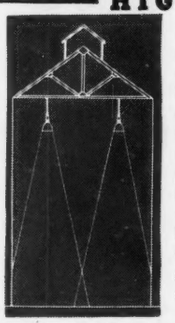
"Does our lighting measure up to the Better Light Standards of modern industrial lighting? Are we using supplementary lighting wherever possible? Do we have lighting problems we do not even know exist?"

Important questions, these, for they have an important bearing on such things as: (1) Production Speed; (2) Rejects; (3) Efficient Operation; (4) Morale; (5) Labor Turnover; (6) Eyesight Conservation; and (7) Accident Hazard.

Yet, these are questions neither your plant superintendent nor any other executive can be expected to answer. For the answer requires not only a knowledge of the hundreds of lighting units as shown in the 288-page Benjamin Catalog No. 26 but also the engineering principles of modern industrial lighting.

Thousands of plant executives rely upon a Benjamin man for a competent *"Checkup"* of their plant lighting. We are confident that you will find it to your advantage to do likewise. A request on your letterhead will bring full details.

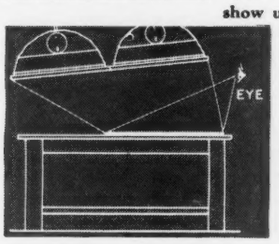
HIGH BAY LIGHTING



Many factory buildings contain high, narrow bays for craneways, foundries, erection floors, pressrooms, etc., as well as locations where the presence of high machinery or overhead obstructions make it necessary that the lighting equipment be mounted at least 35 feet from the floor. To provide these locations with proper lighting, without wasting light high on the side walls of the room, is the purpose of the Benjamin Concentrating Type Alzak Aluminum High Bay Fixtures. They are available in a wide range of models and types.

NEW SKYLIGHT FIXTURE

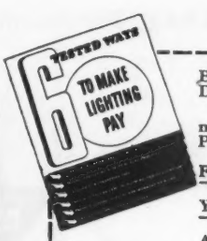
"Skylight" solves the problem of proper lighting for operations and inspection work involving materials with shiny surfaces. Under ordinary light, for example, it is difficult to show up "missed" spots, inadequate plating, and buffing burns on polished plated material. Under the luminous ceiling of artificial light provided by the new Benjamin Skylight unit, these conditions are literally highlighted to the attention of the inspector or operator.



The UNSUSPECTED ROBBER

in industry is inadequate lighting. Its elimination results in (1) Conservation of workers' eyesight; (2) Increased personal efficiency and health of employees; (3) Fewer Accidents; (4) Less Rejects and Spoilage; (5) Reduced Labor Turnover; (6) Smoother, more efficient operation.

BENJAMIN TRADE MARK
Lighting Equipment



Benjamin Electric Mfg. Co., Dept. FMM
Des Plaines, Illinois.

I'd like to go into this subject of lighting, so send me "6 TESTED WAYS TO MAKE LIGHTING PAY" and details of your Checkup Service.

Firm Name _____

Your Name _____

Address _____

City _____ State _____

HOT GALVANIZING

IS TO IRON AND STEEL

Hot dip galvanizing puts a coating on a steel product through which corrosion and rust cannot bite. It is the least expensive real protection ever invented for iron and steel. Only with hot dip galvanizing will you be sure to get adequate thickness of coating. Only with the hot dip method do you get the perfect bond between coating and product formed by molten zinc. By patronizing our members you can be sure of getting a genuine hot dip job and its surety of service . . . If you have a troublesome galvanizing problem, consult our research department. Address American Hot Dip Galvanizers Association, Inc., American Bank Building, Pittsburgh, Penna.

IF IT CARRIES THIS SEAL IT'S A JOB WELL DONE

BUY FROM THESE QUALIFIED MEMBERS

Acme Galvanizing, Inc., Milwaukee, Wis.
Acme Steel & Malleable Iron Works Buffalo, N. Y.
American Tinning & Galvanizing Co. Erie, Pa.
Buffalo Galvanizing & Tinning Works, Inc. Buffalo, N. Y.
Diamond Expansion Bolt Company, Inc. Garwood, N. J.
Enterprise Galvanizing Co., Philadelphia, Pa.
The Fanner Mfg. Company, Cleveland, Ohio
Thomas Gregory Galvanizing Works Maspeth, N. Y.
Henlon-Gregory Galvanizing Company Pittsburgh, Pa.
The Hodell Chain Company, Cleveland, Ohio
Joslyn Mfg. & Supply Co., Chicago, Ill.
L. O. Koven & Brother, Inc. Jersey City, N. J.
Lehigh Structural Steel Co., Allentown, Pa.
Missouri Rolling Mill Corp., St. Louis, Mo.
The National Telephone Supply Co. Cleveland, Ohio
Penn Galvanizing Co., Philadelphia, Pa.
Riverside Foundry & Galvanizing Co. Kalamazoo, Mich.
The Sanitary Tinning Co., Cleveland, Ohio
Standard Galvanizing Co., Chicago, Ill.
Wilcox, Crittendon & Company, Inc. Middletown, Conn.
The Witt Cornice Co., Cincinnati, Ohio

Let improved vision accelerate your production . . . once over with this 90% light-reflective paint does it

● A coat of Luminall on factory interiors is a remarkably profitable investment. Changes dark, sluggish shops into bright, efficient factories.

Luminall is a very flat and intensely white paint that will not yellow with age. It has such great opacity that a lump of coal becomes as white as a snowball when painted with it.

The reason for this great opacity and light reflection is: Luminall has a colorless casein binder permitting double the ordinary amount of pigment to be used—greater pigment exposure—and important optical advantages which you should know about.

Workmen apply it with a wide, labor-saving brush or spray. Dries in 40 minutes. Odorless. Excellent results on new or painted wood, plaster, wallboard, masonry, etc. Luminall comes in paste form and uses only water for a thinner, yet it is a true paint with pigment ground in by regulation paint mills.

Luminall is the standard interior paint in many world-famous and other plants of all sizes where results and costs are what count.

Luminall is packed in quarts, gallons, 5-gallon and 30-gallon drums.

LUMINALL
for All Interiors

NATIONAL CHEMICAL & MFG. CO. (Not Inc.)
3617 So. Wall Street, Chicago
601 W. 26th Street, New York

● The Makers of Luminall want you to know about Luminall. Simply send coupon for booklet.

NATIONAL CHEMICAL & MFG. CO.
3617 So. Wall Street, Chicago
601 W. 26th Street, New York

Please send me your booklet on Luminall paint.

Name & Title.....

Firm.....

Street.....*City*.....*State*.....

THERE *is* A DIFFERENCE IN PUMPS

Mechanically and metallurgically, there are great differences in metals and the way they are fashioned into the finished pump. Look, for instance, at the hard, smooth volutes in F-M centrifugals. No filing mars their hard surface to expose softer, untempered metal. The castings were made *right* at the start.

In design, the differences are myriad. Fairbanks-Morse was the first to streamline its impellers—first to pioneer many invisible refinements that show their value in higher performances, higher efficiencies.

Will your pump dollar buy these extra values in better design, in better manufacture? It WILL, when you specify Fairbanks-Morse.

For full information on F-M pumps for every purpose, address Department O-21, Fairbanks, Morse & Co., 900 S. Wabash Avenue, Chicago, Ill. 34 branches at your service throughout the United States.

6700 PA40-36

106 YEARS OF PRECISION MANUFACTURING

FAIRBANKS-MORSE

Pumps

POWER, PUMPING AND WEIGHING EQUIPMENT

MANY USERS *Know . . .* MORE ARE DISCOVERING—

THE PRACTICAL ADVANTAGES OF SHAFER ROLLER BEARINGS . . . . .

Shafer self-aligning Roller Bearings are proving their unique ability day by day in the widest range of industrial uses. Their free-rolling, load-carrying ability stops power waste; their dependable reserve capacity prevents service interruptions and minimizes maintenance; and their performance is unchanged by severe operating conditions. Simple installation and remarkably long life mean worthwhile economy.

Only the Shafer CONCAVE roller design combines in one simple bearing:

1. Roller bearing capacity for radial, or thrust loads, or any combination of radial-thrust loads.
2. Self-alignment within the bearing itself.
3. Simple adjustability.

Only Shafer offers the full measure of long-lived, trouble-free service in a bearing so simply installed, so readily adapted to industrial uses.

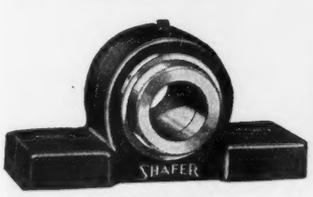
Available in a full range of sizes—Pillow Blocks, Flange Units, Cartridge Units, Take-up Units, Duplex Units, Hanger Boxes, Conveyor Rolls, Radial-thrust Roller Bearings. Write for Catalog 12-A.

SHAFER BEARING CORPORATION

35 East Wacker Drive (Room 2824) Chicago, Ill.

SHAFER

Everything you need in a Roller Bearing



Pillow Block

Flange Unit

Take-up Unit

Hanger Box

Cartridge Unit

Duplex Unit

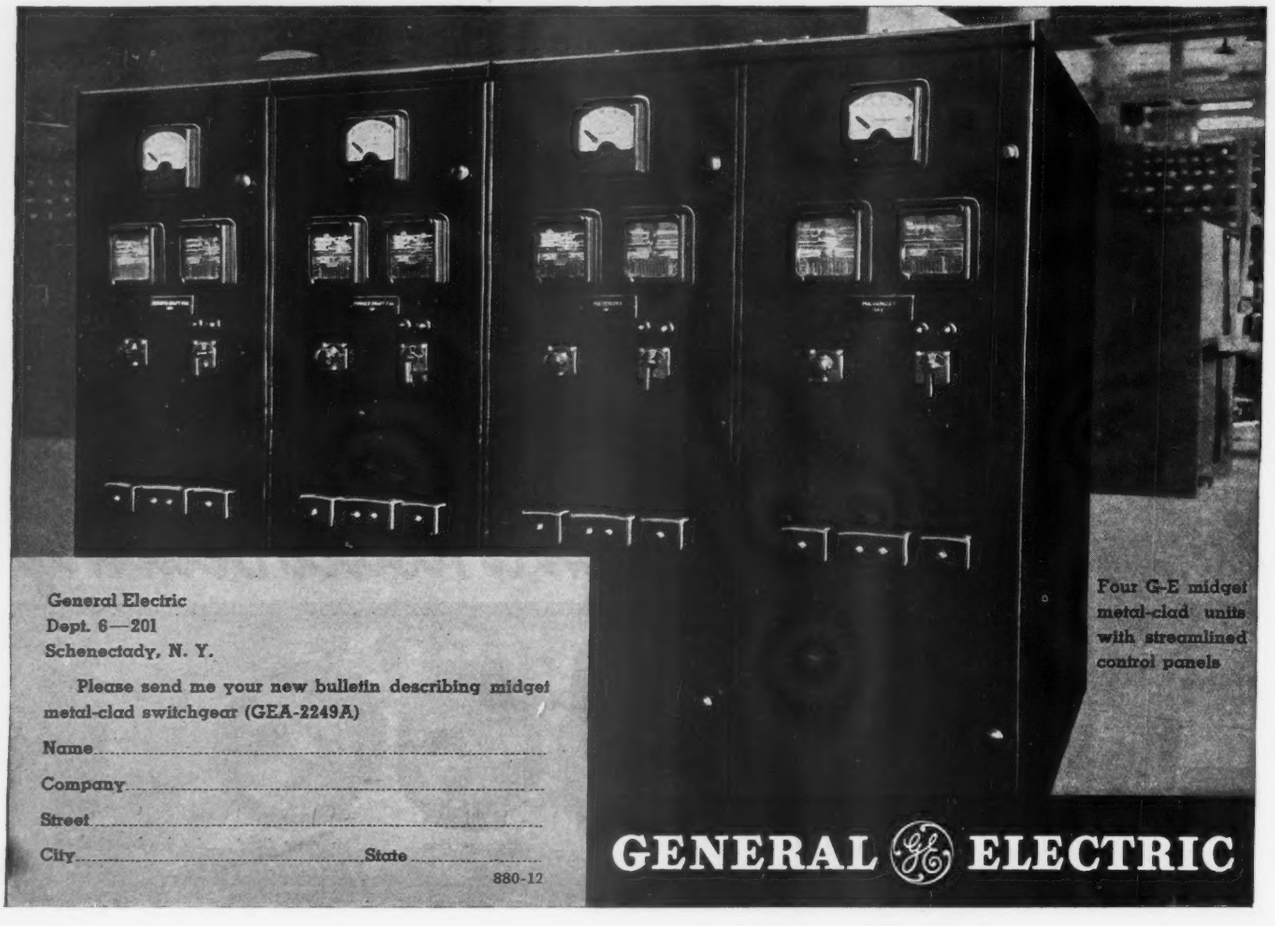
PROTECT YOUR PRODUCTION THIS WAY

WHEN you install G-E midget-metal-clad switchgear in your plant, you are getting one of the best types of production insurance you can buy. Because you are giving your electric circuits and production machinery the swift, sure protection of a famous G-E oil-blast circuit breaker—similar in design to the heavy-duty breakers that power companies, steel mills, and other large industrials rely on for the protection of their highest-capacity electric circuits and equipment.

The midget metal-clad is safe—all live parts are completely enclosed—a system of interlocks guards against incorrect operation.

You will get other advantages, too. It cuts installation costs—you receive it completely assembled, ready to connect. It can readily be moved to a new location should that be desirable. It is moderate in cost.

Why not investigate the many advantages of installing G-E midget metal-clad units in your plant? They are available for services up to 5000 volts; interrupting ratings up to 50,000 kva. For higher-capacity, heavy-duty jobs, rely on the G-E master metal-clad—Type MI-6. Mail the coupon today for complete information. General Electric Company, Schenectady, N. Y.



Four G-E midget metal-clad units with streamlined control panels

General Electric
Dept. 6—201
Schenectady, N. Y.

Please send me your new bulletin describing midget metal-clad switchgear (GEA-2249A)

Name.....

Company.....

Street.....

City..... State.....

880-12

GENERAL ELECTRIC

Fanfold Forms Cut Costs . . .

THE SYSTEM:

(1) *All* your forms written at *one* typing;

(2) Thousands of *sets* of these forms printed on one *continuous* Fanfold strip of paper;

(3) This Fanfold strip *automatically* fed into a Fanfold machine in an *endless* chain;

(4) Carbons *automatically inserted* in each set of forms and used over and over again!

That's the service performed by the famous Fanfold Forms and Underwood Elliott Fisher Fanfold Machines. All the operator does is type—and remove the completed work. Many a machine has paid for itself in the first few months.

Ask practically any railroad. Ask manufacturers in hundreds of lines. Let them tell you of Fanfold's remarkable efficiency. How it provides every department . . . sales, production, shipping; credit, purchasing, accounting . . . with the necessary instructions more quickly, more accurately and at a lower cost than any other available system.

Today, Underwood Elliott Fisher Fanfold Machines cost less than ever. New low prices begin at $190. At this figure they offer even greater savings to any business with multiple forms to write. Telephone the nearest Underwood Elliott Fisher Branch or mail the coupon. Every machine is backed by nation-wide, company-owned service facilities.

Accounting Machine Division
UNDERWOOD ELLIOTT FISHER COMPANY
Accounting Machines . . Typewriters . . Adding Machines . . Carbon Paper, Ribbons and other Supplies
One Park Avenue, New York, N. Y.
Sales and Service Everywhere

Underwood Elliott Fisher Speeds the World's Business

UNDERWOOD ELLIOTT FISHER
Fanfold Machines

Accounting Machine Division
Underwood Elliott Fisher Co.
One Park Avenue, New York, N.Y.

Please mail without obligation to me free copy of "Modern Record Writing the Fanfold Way."

*Name*_____
*Address*_____
*City*_____ *State*_____ FMM12-36

INDUSTRY'S world-wide acceptance of "Clevelands" reaches back across the years a full quarter-century to the day the Company was formed

Yet now, as then, the Company builds Worm Gearing—"and nothing else."

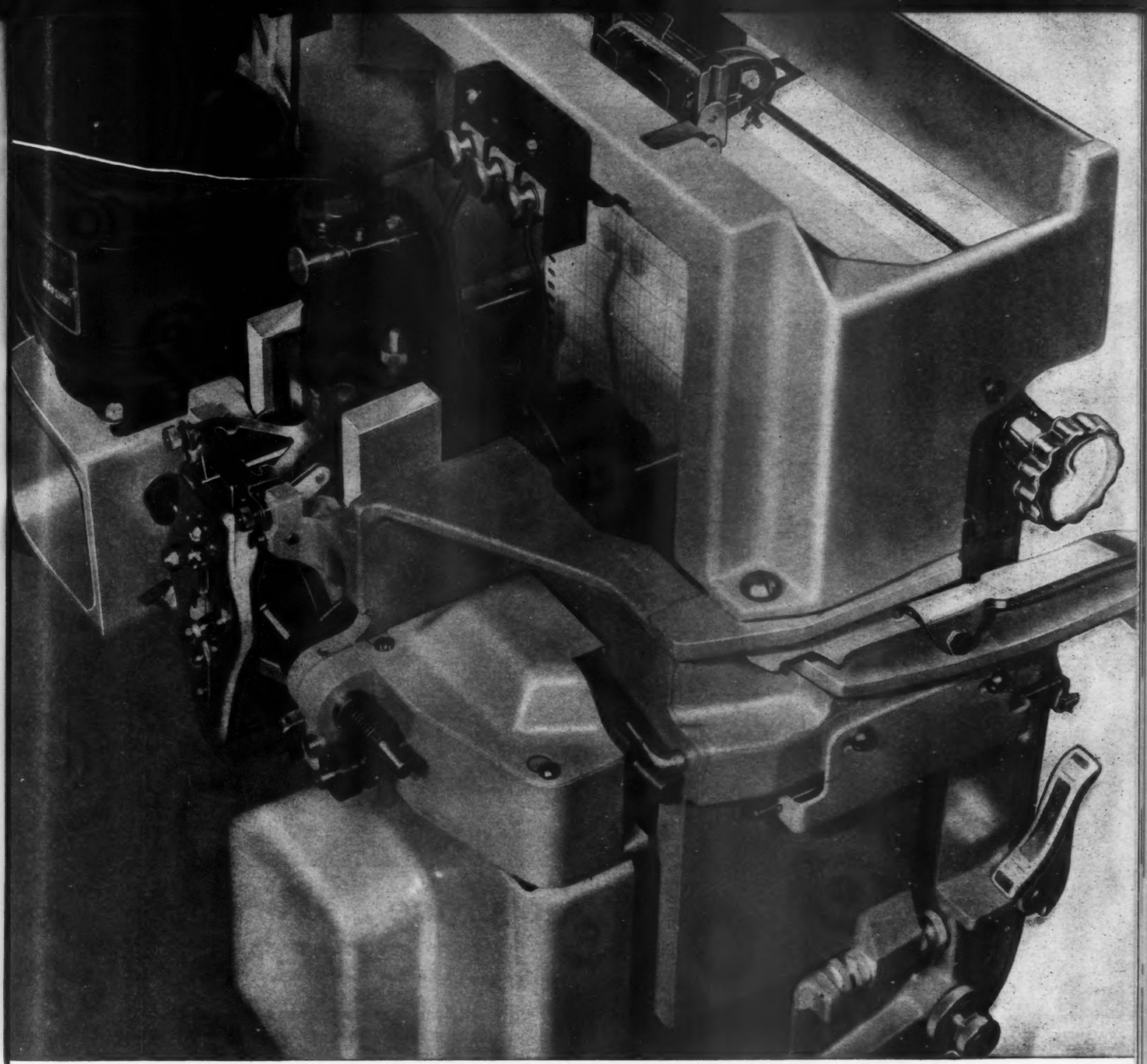
It is perfectly fair to say that "Cleveland's" consistent policy of bringing together and retaining capable, soundly-trained specialists has not only benefitted this Company and its customers, but has helped establish higher standards throughout the industry.

On regular or special drive requirements, this long experience and constant contact with newest applications is at your call through "Cleveland" Engineers located near you. By every practical method of measuring values, "Clevelands" cost you no more than other makes —frequently much less. The Cleveland Worm & Gear Co., 3256 E. 80th St., Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication

★ CLEVELAND *Worm Gear Drives*

AT THAT VITAL POINT, INSTALL CLEVELAND WORM GEAR DRIVES



Micromax Recorder of 100 Uses—Mechanism swung out of its case

Reliability . . . THE FIRST CONSIDERATION

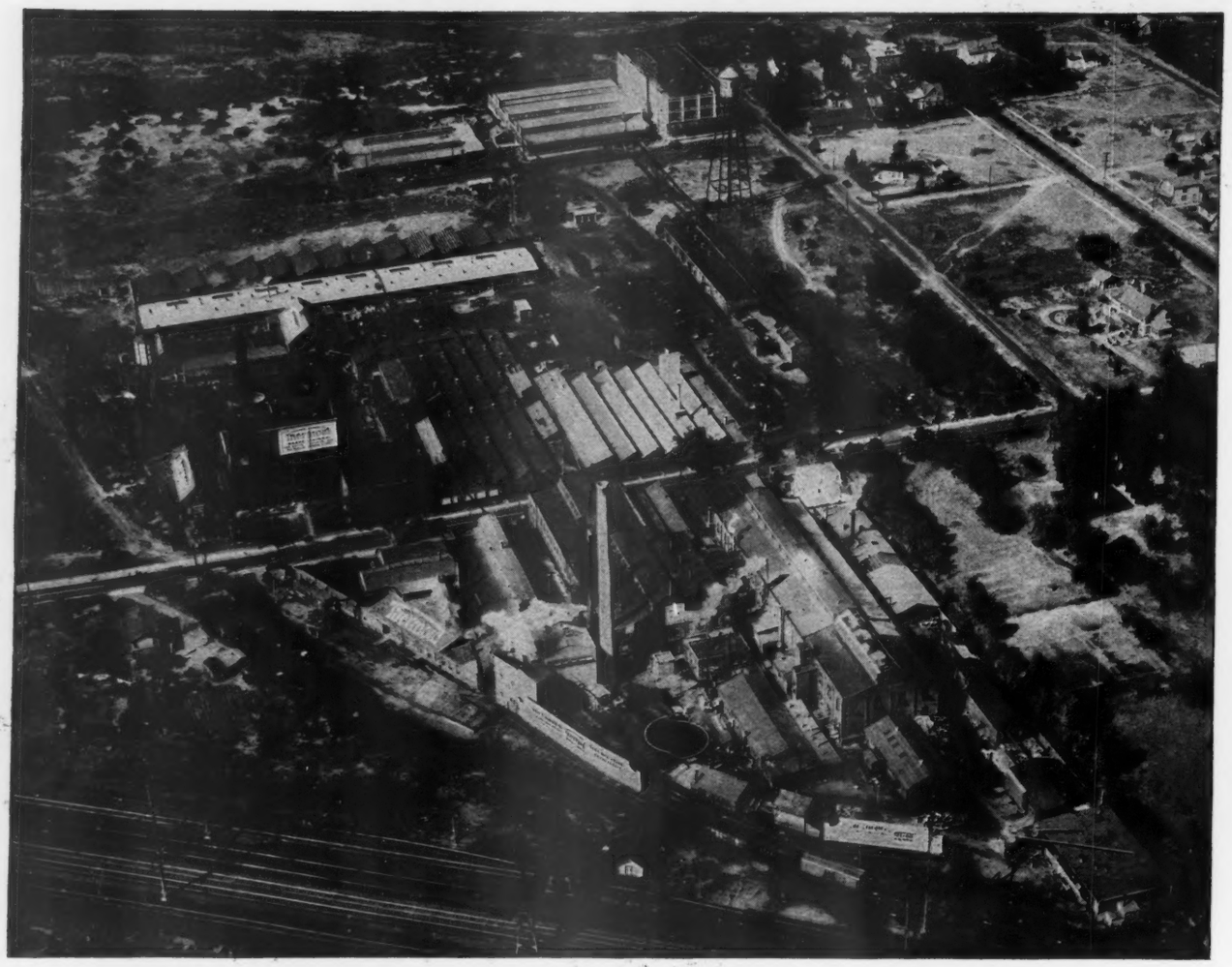
Parts are strong machine types, unique in the instrument art. The materials of which they are constructed have been chosen as a result of exhaustive tests in actual service. Many are heat-treated . . . in Hump-Vapocarb Furnaces. Factors of safety in all are large. Reliability is the first consideration.

J-N33(5)

LEEDS & NORTHRUP COMPANY
4909 STENTON AVENUE PHILADELPHIA, PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS • TELEMETERS • AUTOMATIC CONTROLS • HEAT-TREATING FURNACES



Looking Down on the place . . .
. . . where things are LOOKING UP!

To all our customers and distributors we wish to say, as 1936 draws to a close, "Thank you very much." This year your purchases of Thermoid products have meant an increase of over 30% in our mechanical rubber goods division's business. For 56 years, in fact, Thermoid's sales curve has been climbing.

It is this constantly increasing demand for Thermoid products which is responsible for our large modern plant pictured above. From a small one-story building with less than a score of employees, our factories have expanded to meet the requirements of ever increasing business. New equipment, increased factory floor space, additional employees have all been increasingly required to manufacture a substantial volume of an extremely wide variety of products.

During the coming year every effort will be expended in our laboratories and in our factories not only to maintain, but to further improve the recognized high quality of Thermoid products. This will assure a larger, more satisfactory mutual business in 1937.

Thermoid

TRANSMISSION BELTING
CONVEYOR BELTING
ELEVATOR BELTING

WATER HOSE
AIR HOSE
STEAM HOSE

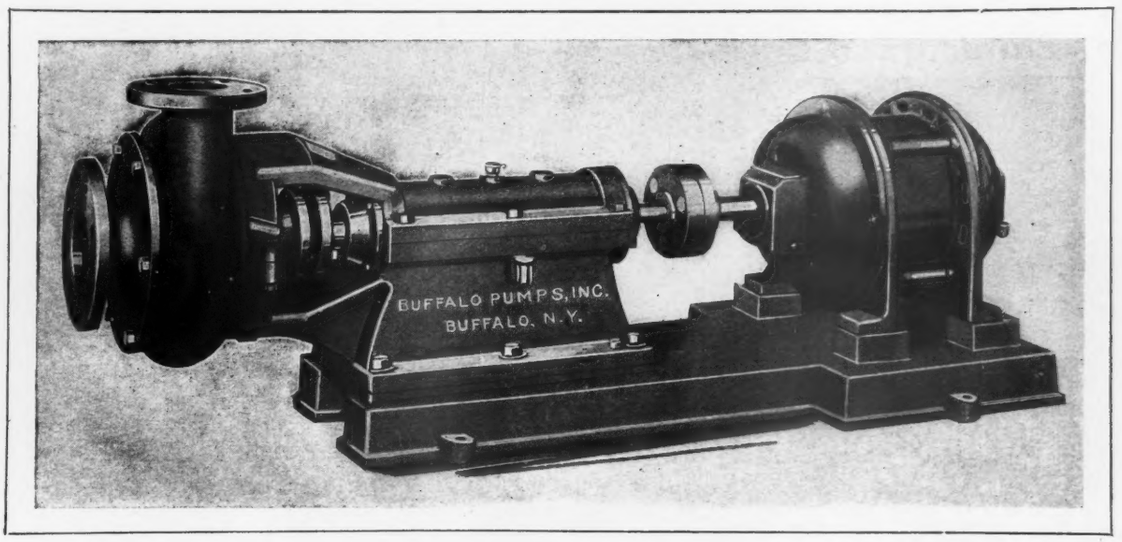
SAND BLAST HOSE
WELDING HOSE
SUCTION HOSE

SHEET PACKINGS
ROD PACKINGS
TUBING · GASKETS

INDUSTRIAL BRAKE LININGS

THERMOID RUBBER COMPANY, TRENTON, N. J.

One Word—
"Performance"



We could write about careful design of impeller, shape of volute, over-size bearings, substantial, vibration-proof base, extra deep stuffing box, and a host of other features of this modern Buffalo pump—but why should we expect you to remember all those things?

So instead—we'll ask you to remember one word when you think of Pumps—the word "Performance." And when you think of Performance—think of Buffalo Pumps.

Why not write for bulletins for your files?

Buffalo Pumps, Inc.

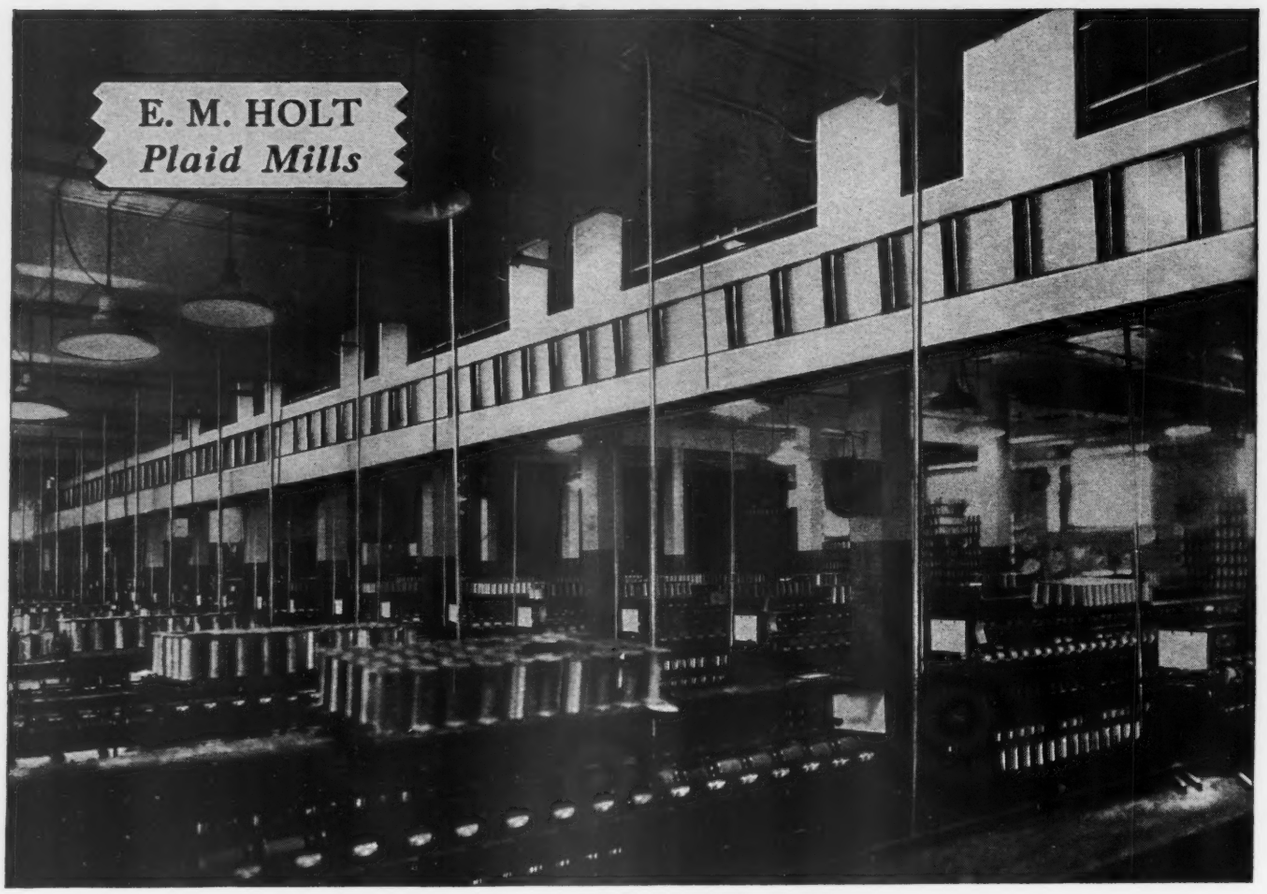
471 Broadway, Buffalo, N. Y.

In Canada: Canada Pumps, Ltd., Kitchener, Ont.

"Buffalo"

Double Ball Bearing Single Suction Pumps

Ousted!



THIS is the silk throwing room of the E. M. Holt Plaid Mill, Burlington, N.C., recently equipped with a complete Sturtevant System for evaporative cooling, heating, humidifying, ventilating, and air cleansing. It has already proved its great value... and its owners are thoroughly pleased with its operation and accomplishments.

Soot is a menace in the vicinity of this mill. This Sturtevant System keeps it out... prevents costly damage to thread and to material. It automatically maintains desired temperature and humidity conditions... thereby aids greatly in maintaining product quality, in preventing production delays and spoilage, in increasing the efficiency of workers. Smoothly and unfalteringly it delivers a uniform flow of clean air, properly humidified, of the right temperature, to every nook, corner, to every part of the throwing room.

Among the users of Sturtevant Evaporative Cooling and Humidifying Systems are American Bemberg, American Enka Corp., Beaunit Mills, DuPont Rayon, Hudson Silk Mill, Industrial Rayon Co., Tubize Chatillon Corp., and others. We would be very glad to cooperate with you as we have with these concerns... and to put our 75 years of air engineering experience at your service.

THE COOLING AND
AIR CONDITIONING CORPORATION
Division of B. F. Sturtevant Co.
HYDE PARK BOSTON, MASS.
Atlanta, Camden, Chicago, Greensboro, New York
Offices in all principal cities

Sturtevant
REG. U.S. PAT. OFF.
Air Conditioning
FOR BETTER PRODUCTS
AT LESS COST

ACMA
PIONEERS IN INDUSTRIAL AIR CONDITIONING

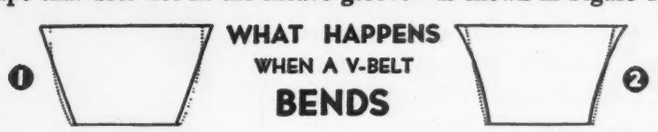
This INTERESTING TEST

Shows exactly how the Concave Side is saving DOLLARS

Wherever Machinery Turns

Bend *any* V-belt and *feel* it change shape. The top, under tension, *narrows.* The bottom widens. The sides of the belt bulge out. The result is a shape that does not fit the sheave groove—as shown in Figure 1, below.

WHAT HAPPENS WHEN A V-BELT BENDS



STRAIGHT SIDED BELT

BELT WITH PATENTED CONCAVE SIDE

Now, bend a V-belt built with the patented *Concave* side. You get the *same* shape change but *now* the new shape *exactly fits* the sheave groove—as shown in Figure 2. There is no side-bulge. Results? (1) *Uniform* side-wall wear; *longer life!* (2) Full side-wall grip on the pulley means no slippage; saves belt wear and *power!*

The Gates Vulco Rope is the only V-belt built with the patented concave side.

Engineering Offices and Stocks in All Large Industrial Centers

THE GATES RUBBER CO., *Factory Branches*

Terminal Bldg. HOBOKEN, N. J.

1524 So. Western Ave. CHICAGO

741 Warehouse St. LOS ANGELES

2213 Griffin St. DALLAS

999 So. Broadway DENVER

GATES VULCO ROPE DRIVES

Crane Unions SIMPLIFY PIPING PROBLEMS, CUT SHUT-DOWN *LOSS*

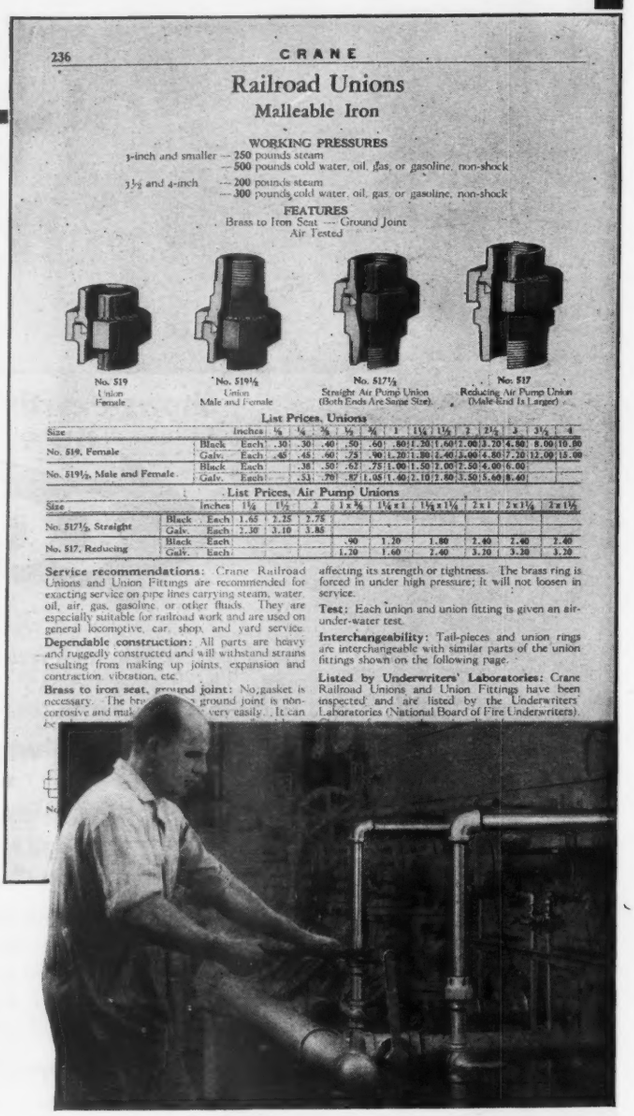
● Crane Malleable Iron Railroad Unions speed up assembly and dismantling of important steam, water, air and other piping in the factory and power plant. They withstand with ease strains resulting from making-up joints, expansion, contraction and vibration. In addition they can be taken apart and reassembled repeatedly without affecting their strength and tightness.

No gasket is necessary as the brass-to-iron ground joint insures tightness. Each union is air-under-water tested. All parts are generously proportioned to insure a high factor of safety. Tail pieces and union rings are interchangeable with similar parts of Crane Malleable Iron Union Fittings.

Frequently, the use of Crane male and female unions and union fittings, instead of only female unions and ordinary screwed fittings, permit complicated piping connections to be made at lower cost, in less time, with fewer joints and, where desired, in smaller space.

The Crane branch or distributor in your vicinity will gladly furnish any assistance desired. He can also fill your needs for Crane quality valves and fittings from stock. The Crane line is complete including valves, fittings, traps, fabricated piping and piping accessories of all kinds.

Let Profits Pay for Plant Improvements. Use the Crane Finance Plan.



236 CRANE

Railroad Unions
Malleable Iron

WORKING PRESSURES
3-inch and smaller — 250 pounds steam
— 500 pounds cold water, oil, gas, or gasoline, non-shock
3½ and 4-inch — 200 pounds steam
— 300 pounds cold water, oil, gas, or gasoline, non-shock

FEATURES
Brass to Iron Seat — Ground Joint
Air Tested

No. 519 Union Female
No. 519½ Union Male and Female
No. 517½ Straight Air Pump Union (Both Ends Are Same Size)
No. 517 Reducing Air Pump Union (Male End Is Larger)

List Prices, Unions

Size	Inches	⅛	¼	⅜	½	¾	1	1¼	1½	2	2½	3	3½	4
No. 519, Female	Black Each	.30	.30	.40	.50	.60	.80	1.20	1.60	2.00	3.20	4.80	8.00	10.80
	Galv. Each	.45	.45	.60	.75	.90	1.20	1.80	2.40	3.00	4.80	7.20	12.00	15.00
No. 519½, Male and Female	Black Each			.38	.50	.62	.75	1.00	1.50	2.00	2.50	4.00	6.00	
	Galv. Each			.53	.70	.87	1.05	1.40	2.10	2.80	3.50	5.60	8.40	

List Prices, Air Pump Unions

Size	Inches	1¼	1½	2	1 x ¾	1¼ x 1	1½ x 1¼	2 x 1	2 x 1¼	2 x 1½
No. 517½, Straight	Black Each	1.65	2.25	2.75						
	Galv. Each	2.30	3.10	3.85						
No. 517, Reducing	Black Each				.90	1.20	1.80	2.40	2.40	2.40
	Galv. Each				1.20	1.60	2.40	3.20	3.20	3.20

Service recommendations: Crane Railroad Unions and Union Fittings are recommended for exacting service on pipe lines carrying steam, water, oil, air, gas, gasoline, or other fluids. They are especially suitable for railroad work and are used on general locomotive, car, shop, and yard service.

Dependable construction: All parts are heavy and ruggedly constructed and will withstand strains resulting from making up joints, expansion and contraction, vibration, etc.

Brass to iron seat, ground joint: No gasket is necessary. The brass ground joint is non-corrosive and ma… very easily. It can … affecting its strength or tightness. The brass ring is forced in under high pressure; it will not loosen in service.

Test: Each union and union fitting is given an air-under-water test.

Interchangeability: Tail-pieces and union rings are interchangeable with similar parts of the union fittings shown on the following page.

Listed by Underwriters' Laboratories: Crane Railroad Unions and Union Fittings have been inspected and are listed by the Underwriters Laboratories (National Board of Fire Underwriters).

For complete description, working pressures, prices and dimensions on Crane Malleable Iron Railroad Unions, see page 236, new Crane No. 52 Catalog

CRANE

CRANE CO., GENERAL OFFICES: 836 S. MICHIGAN AVE., CHICAGO, ILLINOIS • NEW YORK: 23 W. 44TH STREET

Branches and Sales Offices in One Hundred and Sixty Cities

VALVES, FITTINGS, FABRICATED PIPE, PUMPS, HEATING AND PLUMBING MATERIAL

WITH BETTER LIGHT · BETTER SIGHT

● Plan for better light in 1937 by seeing what High Intensity Mercury lighting will do for you. Install a Comparizone of Mercury lighting now, and compare this zone on *every* basis with a similar zone of ordinary lighting.

You'll see why industry everywhere is standardizing on High Intensity Mercury lighting. You'll find it provides two to three times more light than ordinary light sources . . . and with a rated lamp life of 2,000 hours, you get *more light for your money!*

Call your local Westinghouse Distributor today. He will gladly work with you in planning a test zone or a complete installation. He is best qualified to work with you because the complete Westinghouse High Intensity Mercury lighting line includes the exact equipment suited to your needs.

Westinghouse alone makes available complete equipment . . . reflectors, transformers, lamps and accessories. Use the convenient coupon to get complete facts of its advantages to you.

WRITE FOR DETAILS

WHEN YOU THINK OF *Lighting* THINK OF

Westinghouse

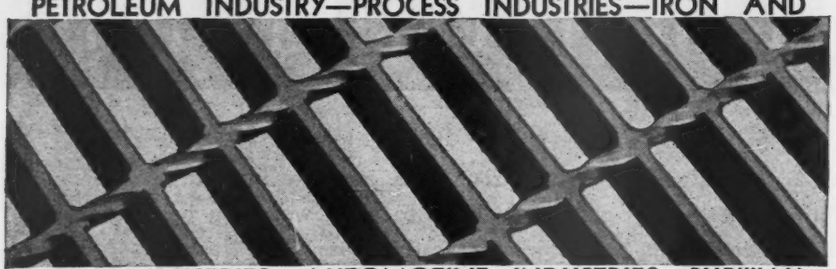
Westinghouse Electric & Mfg. Co.
Lighting Division,
Edgewater Park, Cleveland, Ohio
We would like more information on High Intensity Mercury Lighting.

(Name, Company and Address below)

THEY USE BLAW-KNOX *Electroforged* GRATING AND STAIR TREADS

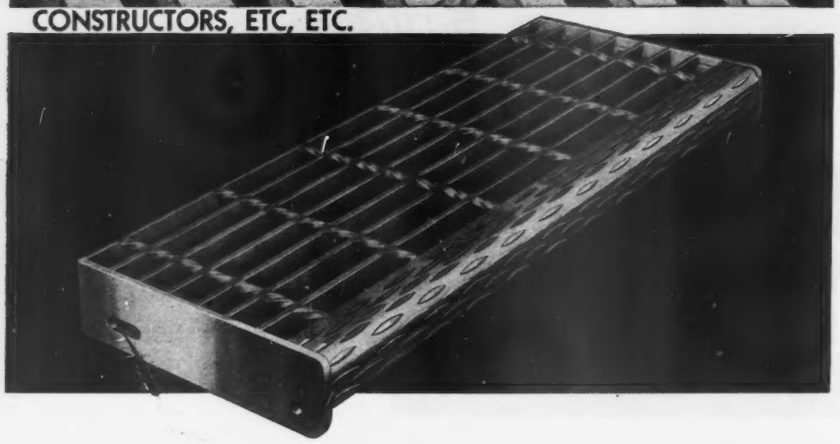
INDUSTRIAL AMERICA—INCLUDING PUBLIC UTILITIES—

PETROLEUM INDUSTRY—PROCESS INDUSTRIES—IRON AND



STEEL INDUSTRIES—AUTOMOTIVE INDUSTRIES—SUBWAY

CONSTRUCTORS, ETC, ETC.

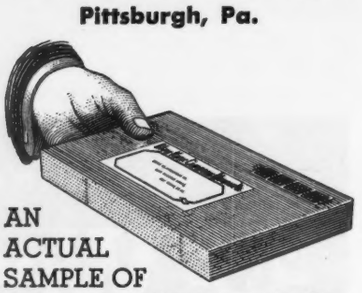


BECAUSE

THEY OBTAIN THESE FEATURES WITHOUT EXTRA COST

- ☑ Electroforged, one piece construction—strongest by test.
- ☑ Safest footing because of the twisted bar.
- ☑ Self-cleaning no sharp corners to clog with debris.
- ☑ Maximum open area for light and air.
- ☑ Easily maintained. No cracks or crevices; paint reaches entire surface.

BLAW-KNOX CO.
2031 Farmers Bank Bldg.
Pittsburgh, Pa.

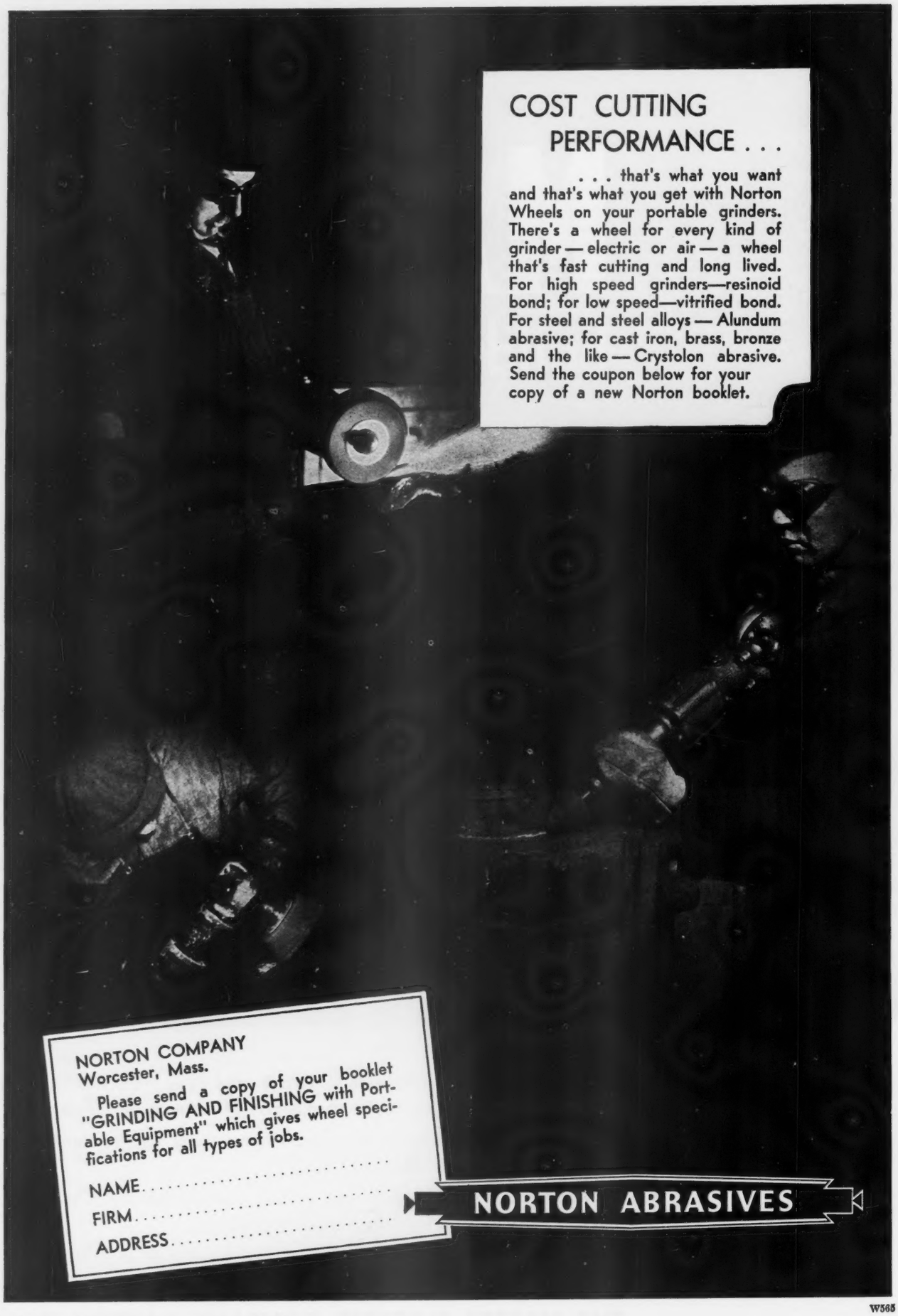


AN ACTUAL SAMPLE OF ELECTROFORGED GRATING IS YOURS FOR THE ASKING

MASTER
builds the complete unit

- **INTEGRAL CONSTRUCTION**—In Master Geared Head Motors, both motors and gears are designed and built by one organization into a well balanced unit.
- **GUARANTEED AS A UNIT**—Undivided responsibility for the satisfactory operation of the entire unit.
- **GREATER FLEXIBILITY**—Master can readily modify either the motor or gear unit to fit exactly your individual requirements.
- **SIMPLIFIED DESIGN**—More compact—permanent alignment—longer, trouble-free operation.

THE MASTER ELECTRIC COMPANY, DAYTON, OHIO


COST CUTTING
PERFORMANCE . . .
. . . that's what you want and that's what you get with Norton Wheels on your portable grinders. There's a wheel for every kind of grinder — electric or air — a wheel that's fast cutting and long lived. For high speed grinders—resinoid bond; for low speed—vitrified bond. For steel and steel alloys — Alundum abrasive; for cast iron, brass, bronze and the like — Crystolon abrasive. Send the coupon below for your copy of a new Norton booklet.
NORTON COMPANY
Worcester, Mass.
Please send a copy of your booklet "GRINDING AND FINISHING with Portable Equipment" which gives wheel specifications for all types of jobs.
NAME.....
FIRM.....
ADDRESS.....
NORTON ABRASIVES

W565

3¢ for a letter to Doc. Steelstrap starts your shipping packages on the road to better "health"

Doc. Steelstrap's BULLETIN EXTRA

EDITED BY ACME STEEL COMPANY

General Offices: 2831 Archer Avenue, Chicago • Branches and Sales Offices in Principal Cities

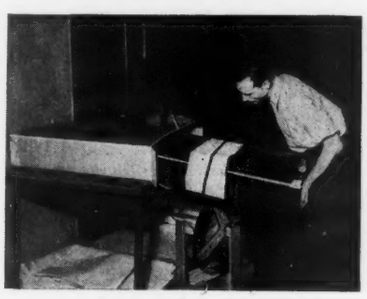
HERE'S THE FAMOUS ACME SEAL—that Makes Shipments "Bound to Get There"

MY ACME STEEL-STRAP, with the Acme Sealed Joint, correctly placed about a well-designed shipping package can mean big sums of money saved each year. For shippers in almost every business, I find ways to make improvements through the use of Acme Steelstrap, and show them how to save money. Let me give your containers, wood or fibre boxes, crates, bundles—any kind—a thorough "going over." No charge. Just write me. I'll also send a copy of My New STRAP-BOOK.

Doc. Steelstrap

Inside Dope on Cutting Costs

The ABC Steel Equipment Co., of New York City, manufactures this display stand. U. S. Rubber, as you can see, uses it. Set up, the stand is of considerable size. Taken down, it is quite a shipping job. They put all the parts in one neat "parcel" tied securely with Acme Steelstrap. The unit is then slipped into a corrugated container, and sent on its way. Simple. Economical. Fast and secure. Acme Steelstrap and my treatments are continually showing shippers new ways to cut costs. Write today and tell me about your shipments. You can trust me—to help you.



MONEY SAVER FOR MEAT

Here's a load of salt pork riding for lower rates, because it's braced with Acme Unit-Load. This finest method of bracing all kinds of carload and truck freight can cut bracing costs by a big percentage—save time, and avoid damage. Meat products are only one commodity that's "using" Acme Unit-Load. Foods of all kinds, hardware, chemicals, brick, plumbing—virtually every product imaginable can be braced for less with Unit-Load. Write today for a copy of the new Unit-Load Booklet, filled with real facts on money-saving methods.

Send this Memo to Doc. Steelstrap today. It can be the first step toward lower shipping costs. Free diagnosis of your Shipping Cases.

FLASH

SEATTLE, WASH.
Wholesale grocer now knows his cartons will be "Bound to Get There" because of Steelstrap.

SAN FRANCISCO, CALIF.
Five-gallon tin cans bundled in units of nine with Steelstrap for economy and protection against denting.

BIRMINGHAM, ALA.
Tanks braced on flat cars with Steelstrap. Costly wood bracing eliminated.

NEW YORK CITY
Insulating panel boards bundled with Steelstrap.

HOLLYWOOD, CALIF.
Well-known cosmetic maker ships lipstick abroad in Steelstrapped cases.

MEMO

Acme Steel Company
General Offices: 2831 Archer Ave., Chicago, Ill.

Oh Doctor! Save our shipping cases from that awful disease Hi-Costitis. We understand you charge nothing.

Name.....

Firm.....

Address.....

City..... State.....

Product Shipped.....

THIS striking photograph of USS Multigrip Floor Plate by Gerald O. Young has won great distinction wherever it has been exhibited. In Detroit it was called "an outstanding example of Industrial Photography." In Chicago it was a prize-winner. Critics everywhere admired its composition, its fine lighting, its unusual choice of subject. But to the critical buyer of flooring this picture means more than that. It means extra safety, comfort, and cleanliness . . . a special fitness for industrial use.

A *Prize-winning* Photograph of *a Prize-Winning* Floor Plate

HERE is truly a prize winning combination—the photograph by Gerald O. Young—the USS Multigrip Floor Plate by Carnegie-Illinois Steel Corporation. Here Mr. Young has focused attention on the reasons why even leather shoes grip securely, safely on the risers of Multigrip — why Multigrip is comfortable to stand or walk on—why it provides good traction for wheeled vehicles—resists skids or slides.

And Multigrip is easy to sweep clean, too. The modified lozenge shape of the risers leaves no pockets to catch dirt. It drains quickly and completely. Neat installations can be made at minimum cost—without waste in cutting—because the pattern in Multigrip is continuous whether adjoining plates are laid end to end or side to side. Write us for prices and data on weights and thicknesses. You'll be surprised to find that Multigrip gives you all these advantages and still costs no more than ordinary floor plate.

U·S·S MULTIGRIP FLOOR PLATE

CARNEGIE-ILLINOIS STEEL CORPORATION

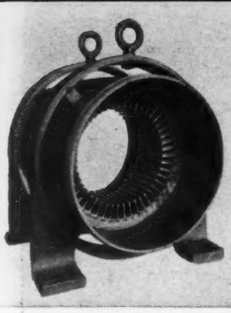
Pittsburgh *Chicago*

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*

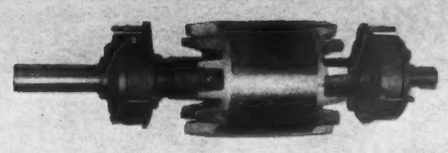
United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

ENCLOSED FAN-COOLED TYPE AA RELIANCE INDUCTION MOTOR
(SQUIRREL-CAGE FRAMES 202 405 WITH BALL BEARINGS)

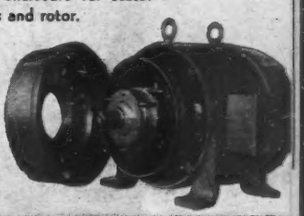


Permanent alignment and uniform air gaps are assured by Reliance's use of a rigid all-steel frame, electrically welded.



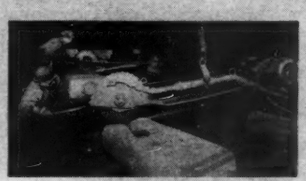
Rotor bars, short-circuiting rings and fans are cast of aluminum as a single unit of uniform structure without joints. Ball bearings are mounted in dust-tight cartridges.

The frame rings are rolled from heavy steel plate. With the end shields, they form a dust-tight enclosure for stator windings and rotor.



Reliance AIDS PREVENTIVE MAINTENANCE

An oily mess of iron dust and chips often collects on the windings of open motors in metal-working plants. It's a sure cause for burn-outs. You can prevent it with fan-cooled motors.



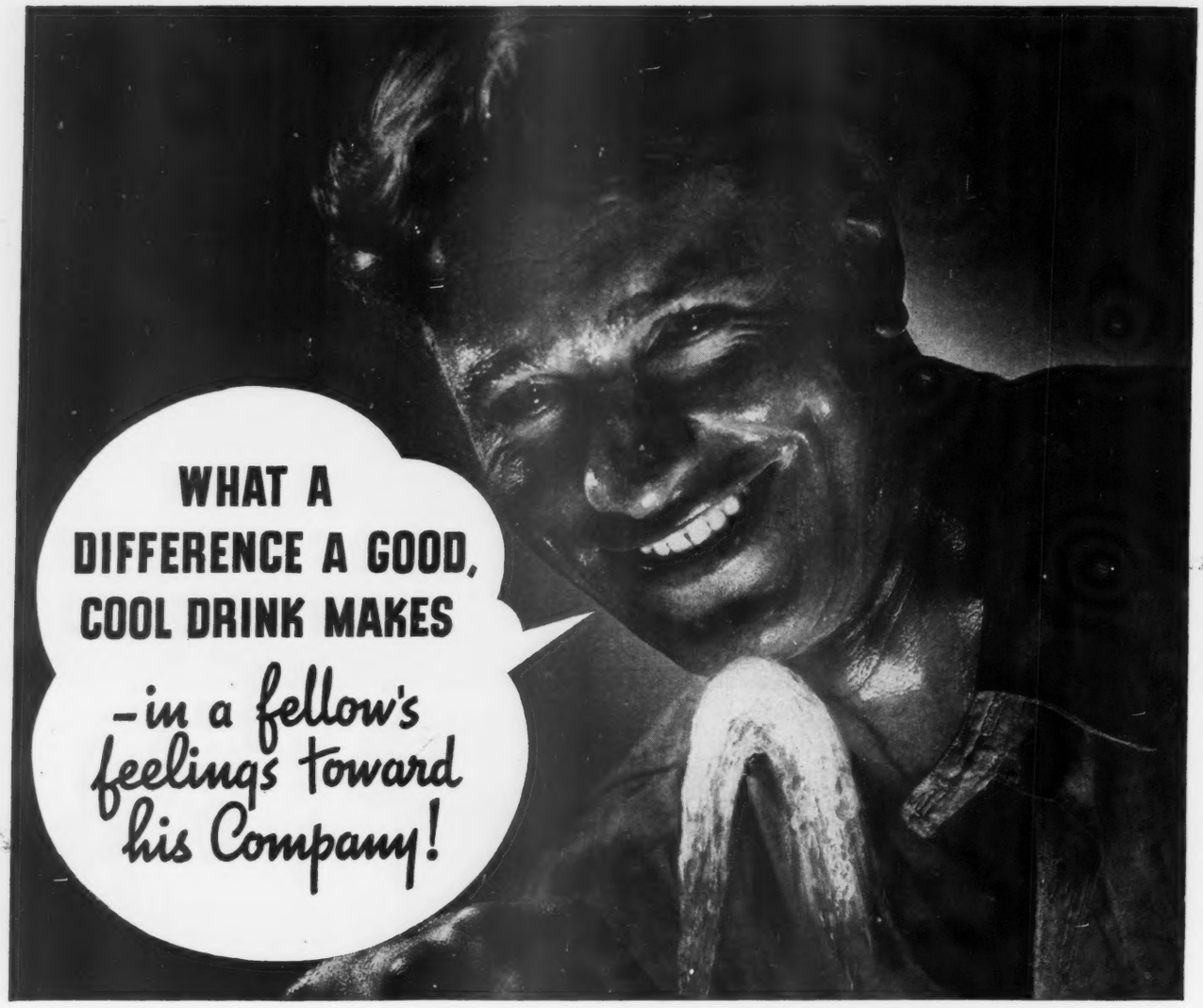
Fan-cooled motors on these swing grinders give complete protection without excess size or weight.

THIS protected motor is a worthy ally of the modern Maintenance Engineer. It fits today's idea of *preventing* instead of *fixing* . . . Reliance fan-cooled design retains the ruggedness of Type AA open motors. Simply but effectively, it shuts up motor parts against their enemies—against iron dust, chips and moisture. Windings stay clean and dry, air gaps clear . . . Prevention that saves repairs—that's the idea—preventive maintenance that avoids breakdowns and production delays. Lower upkeep, longer life, steadier operation soon wipe out the differential in initial cost. Bulletin 120 gives the details.

RELIANCE ELECTRIC & ENGINEERING COMPANY
1088 Ivanhoe Road Cleveland, Ohio

Branches: Boston, Buffalo, Chicago, Cincinnati, Detroit, Greenville (S. C.), New York, Philadelphia, Pittsburgh. *Representatives in other principal cities.*

RELIANCE A-C D-C MOTORS



FOR GOOD WILL AND GOOD WORK, MODERNIZE

with Frigidaire Water Cooling Equipment

● No investment you can make in plant modernization will pay bigger dividends than Frigidaire Water Cooling Equipment. In goodwill alone it more than justifies its cost.

But it offers many other advantages as well. It means greater efficiency in every department—more production, fewer mistakes and accidents. It also means a tremendous saving in dollar and cents over old-style methods. A saving so great that Frigidaire actually pays for itself in a short time and continues to earn a big investment return for years to come.

When we say "pays for itself" we mean just that. And we're ready to *prove* it to *you* by a FREE survey and estimate in your own plant.

It will pay you to get complete details. Find out how little it costs you and how much it saves you to have cool, sparkling water throughout your factory. There is Frigidaire Water Cooling Equipment for every need. Efficient, dependable, economical.

Investigate at once, and include Frigidaire equipment in your 1937 budget. For free survey and estimate see your nearest Frigidaire Commercial dealer or drop a line to FRIGIDAIRE DIVISION, General Motors Sales Corporation, Dept. 68-12, Dayton, Ohio.

FRIGIDAIRE
MADE ONLY BY GENERAL MOTORS

You Need REEVES Speed Control to Insure

1. PERFECT TIMING

A REEVES-controlled machine can be timed to a split second. It can be speeded up or slowed down to exactly the rate required for best results. Easy to meet changes in production schedules, differences in size, shape, composition or bulk of products, new sequences in processing, differences in number or skill of operators. Prevents waste of time and material.

2. ACCURACY

With REEVES speed control, you don't approximate the correct speed, you secure it *exactly;* and maintain it with absolute accuracy as long as desired. There is *no* slippage—and *no* fluctuation—at any speed, even under varying load. Positive and efficient transmission of power over the complete range required. Makes any machine a new instrument of precision.

3. PROPER TENSION

In processes dealing with continuous flow of material—such as textiles or paper—from one machine or section to another, correct tension on material is indispensable. Through REEVES automatic control, exactly the proper tension is established and maintained—compensating for variances in type or moisture content of product, temperature, humidity, etc.

4. SYNCHRONIZATION

Through the use of REEVES Transmissions plus automatic control, related machines or sections of machines may be perfectly synchronized in speed to permit a smooth, continuous flow of materiai from one machine or section to the next. Entire production lines may be synchronized, yet easily and quickly varied in pace to meet changing production requirements.

5. DESIRED VOLUME

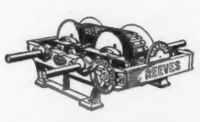
Maintaining volume—such as a fixed level of liquid in a tank—is another job for the REEVES Transmission. A float or pressure regulator is used to actuate Transmission, increasing or decreasing flow of liquid *into* the tank in direct proportion to amount of liquid taken *from* the tank. Similar regulating mechanism used with pumps, filling and capping processes, etc.

6. UNIFORMITY

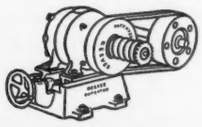
Uniform quality can be secured at a faster rate on a REEVES-regulated machine. Different shapes and sizes of products—different heating or cooling requirements—variances in moisture content, viscosity, density or hardness of raw materials—EACH of these variable factors can be offset by the correct, compensating change in speed. Simplifies product control.

It's the "variables" that cause trouble in manufacturing processes. You can't eliminate these variables. But you can *control* them. A simple, accurate and dependable way is through variable speed regulation as provided by REEVES units. Don't be satisfied with the operation of any production machine in your plant unless it has complete speed adjustability. Don't remain in doubt as to how speed control can be applied or what it will accomplish. Ask REEVES engineers, and let us make a recommendation based on our experience in applying variable speed control to more than 80,000 machines in over 16,000 plants. A complete line of time-tested speed control units to choose from—insuring the correct size, design, type, speed ratio and control to meet your individual requirements.

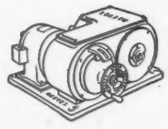
THE 3 BASIC REEVES UNITS



VARIABLE SPEED TRANSMISSION—for absolute accuracy over a wide range; fifteen sizes, fractional to 100 h. p., and speed variations from 2:1 to 16:1 inclusive.



VARI-SPEED MOTOR PULLEY—forms direct drive from motor to the driven machine. Seven sizes, from fractional to 7½ h. p. Provides speed variations over 3:1 range.



VARI-SPEED MOTO-DRIVE—combines motor, speed varying mechanism and reduction gears (where required). Horizontal and vertical; ¼ to 10 h. p.; speed variations 2:1 to 6:1.

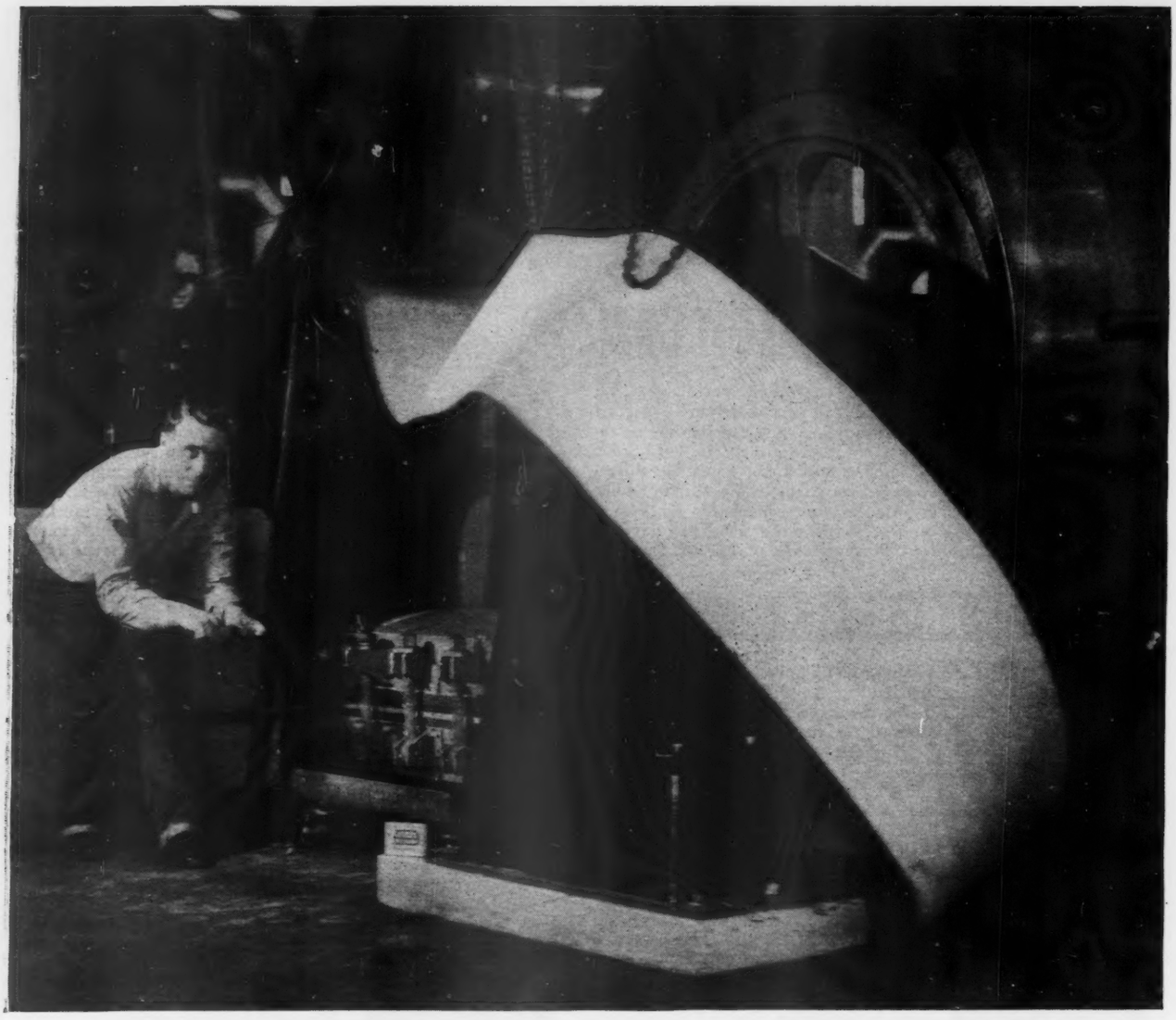
REEVES PULLEY COMPANY, COLUMBUS, IND.

Send, without obligation, copy of your comprehensive 112-page Speed Control Handbook. (F-12-36)

Name.....

Company.....

Address.....



HE MAKES THE BELT SWALLOW ITS TAIL

A typical example of Goodrich improvement in rubber

FOR 40 years manufacturers tried to find a better way to make rubber belts endless.

Splices, vulcanized like tire repairs, would hold for a short time, then begin to open up at the seams. Plan after plan was tried, each plan designed to make splices *stronger and stronger*. Joints were made which seemed stronger than any other part of the belt! Still they failed.

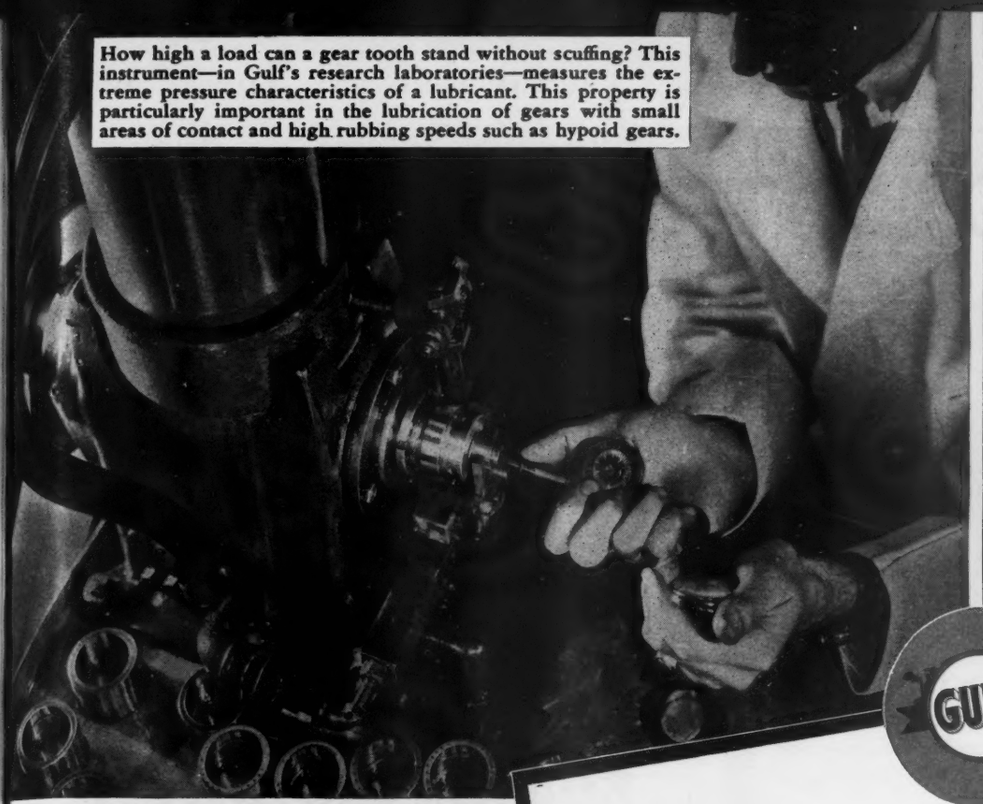
One day Goodrich belt men decided that strength alone wasn't the answer. The outside belt plies must stand quick stretching and relaxing millions of times. Belts travel so fast that air resistance is important. These men decided they must protect those outer seams at any cost. So they reversed the usual engineering procedure, designed a splice in which a small section of an inner ply is removed, the outside ply carried under the surface at the seam, and covered with elastic breaker fabric.

Belts with this new Plylock splice lasted sometimes twice as long, sometimes ten times as long as the old belts. Users constantly tell us of serious belting problems which have been completely solved.

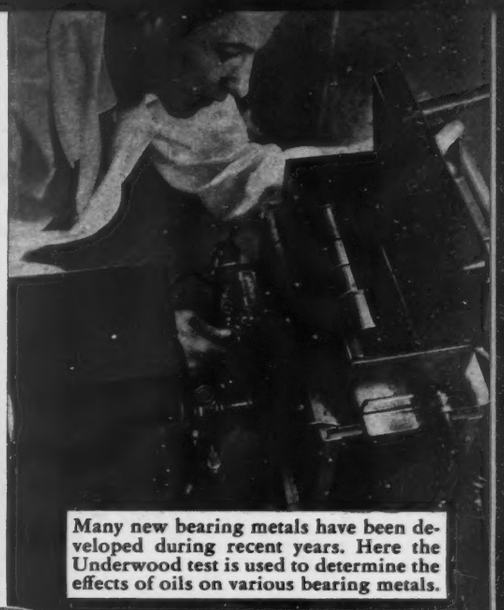
Goodrich is always busy with development work on rubber products. Much of it applies to new products, new uses —but no product is too "staple" or too *standardized* to get its share of this work. Goodrich improvements in rubber extend to conveyor belts, rubber-lined pipe, steam hose, suction hose—hundreds of other things classed generally as mechanical rubber goods. The B. F. Goodrich Company, Mechanical Rubber Goods Division, Akron, Ohio.

Goodrich

ALL *products problems* IN RUBBER



How high a load can a gear tooth stand without scuffing? This instrument—in Gulf's research laboratories—measures the extreme pressure characteristics of a lubricant. This property is particularly important in the lubrication of gears with small areas of contact and high rubbing speeds such as hypoid gears.

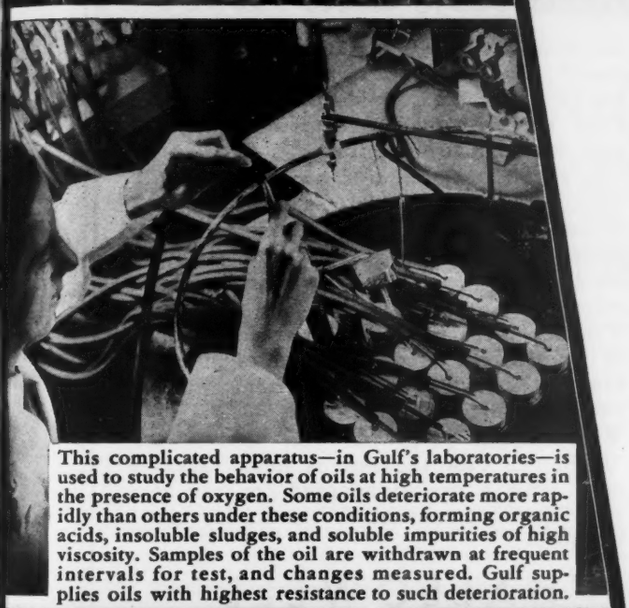


Many new bearing metals have been developed during recent years. Here the Underwood test is used to determine the effects of oils on various bearing metals.

GULF INDUSTRIAL LUBRICATION

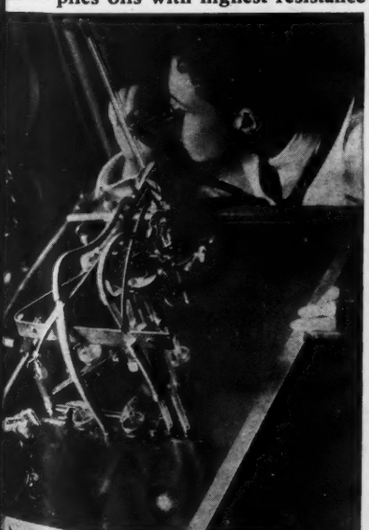
Know WHAT'S BEHIND QUALITY CLAIMS WHEN YOU BUY LUBRICANTS ...*Industrial or Automotive*

GULF REFINING COMPANY
GULF OIL CORPORATION
GENERAL OFFICES: GULF BUILDING
PITTSBURGH, PA.

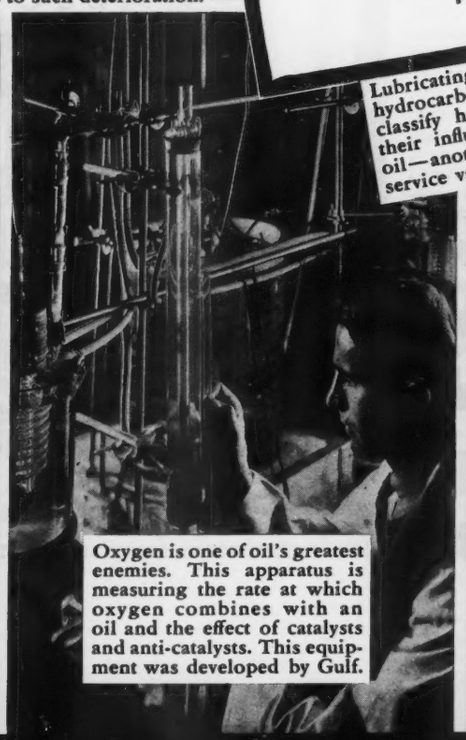


This complicated apparatus—in Gulf's laboratories—is used to study the behavior of oils at high temperatures in the presence of oxygen. Some oils deteriorate more rapidly than others under these conditions, forming organic acids, insoluble sludges, and soluble impurities of high viscosity. Samples of the oil are withdrawn at frequent intervals for test, and changes measured. Gulf supplies oils with highest resistance to such deterioration.

Lubricating oils contain many types of hydrocarbon molecules. Gulf scientists classify hydrocarbons with respect to their influence on the stability of the oil—another step to insure the high service value of Gulf quality lubricants.



The "Chemist's Aquarium." This adiabatic thermostat measures extremely small temperature changes due to chemical reaction in an oil. The data secured are valuable in certain fundamental studies.



Oxygen is one of oil's greatest enemies. This apparatus is measuring the rate at which oxygen combines with an oil and the effect of catalysts and anti-catalysts. This equipment was developed by Gulf.

A new machine developed by Gulf engineers—the first that will test any bearing under precisely the operating conditions of actual service. It measures accurately friction, torque, temperature, wear and film thickness. Thus, Gulf research engineers develop new information which is useful in the manufacture of improved bearing lubricants.

MEMO

NOTE — is the international trade mark of the Leipzig Trade Fairs.

Put Feb. 28 on your calendar

This date concerns your business. It marks the 16th annual opening of the Great Engineering and Building Fair at Leipzig, Germany. More than 2,500 firms will exhibit machinery (practically all in operation), equipment and manufacturing processes for every industry. These exhibits fill 17 gigantic buildings and 10 acres of outdoor space.

Only by covering this Fair (Feb. 28 to Mar. 8), can you know what the whole world offers in your business. You may not be in the market for any machinery or equipment. But you cannot fail to build profits out of the ideas you receive—and the opportunity to meet men in your own line of business from every civilized country of the world. At the same time, you can visit the General Merchandise Fairs (Feb. 28 to Mar. 5)—featuring 6,000 exhibits of finished and semi-finished goods.

Leipzig exhibitors come from 25 countries. More than 230,000 business executives, engineers and buyers from 72 countries inspect the exhibits.

Please write for Booklet No. 22 today. Let us help you determine the profit possibilities for *your* firm, offered by these Fairs.... Leipzig Trade Fair, Inc., 10 East 40th Street, New York.

The 2,500 technical exhibits include:—building and construction equipment and sanitary engineering; electrical equipment; iron and steel products, mechanics' tools and materials, semi-finished products; machine tools for metals, wood, glass and similar materials; machinery and apparatus for food, food luxuries, chemical and ceramic industries, packing machines; machinery for textiles, paper and similar products and machinery for the graphic arts; power machinery, heating, foundry and gas fuel engineering; pumps, compressors, transportation and conveying equipment, etc. And probably 500 new inventions.

THE GREAT ENGINEERING AND BUILDING FAIR

A DIVISION OF THE 700-YEAR-OLD

LEIPZIG TRADE FAIRS

Fig. 1334 — Fig. 1249 Pat. App. for — Fig. 1267 Pat. App. for

"HALLOWELL" STEEL STOOLS

- are Designed to keep the worker Efficient and Alert

Do your workers slow up in the afternoon? Do they appear more tired and less efficient than would seem normal? Poor posture, due to incorrect seating, may be the cause of this.

"Hallowell" Steel Stools and Chairs are scientifically designed to assure a natural sitting position, with no undue strain or tenseness on any part of the body. Remember — comfortable workers do more.

The one piece welded steel construction of "Hallowell" stools and chairs makes them last longer—another item when you're considering profits.

You can get just what you need in a "Hallowell" for the line is most extensive, with a design adapted for use at any type of operation. Write us for our catalog.

"HALLOWELL" STEEL WORK BENCHES

For longer life—greater rigidity . . . freedom from splintering and all 'round, long run economy—investigate "Hallowell" Steel Work Benches.

Fig. 732 Pat'd and Pats. Pending

Other S. P. S. Products

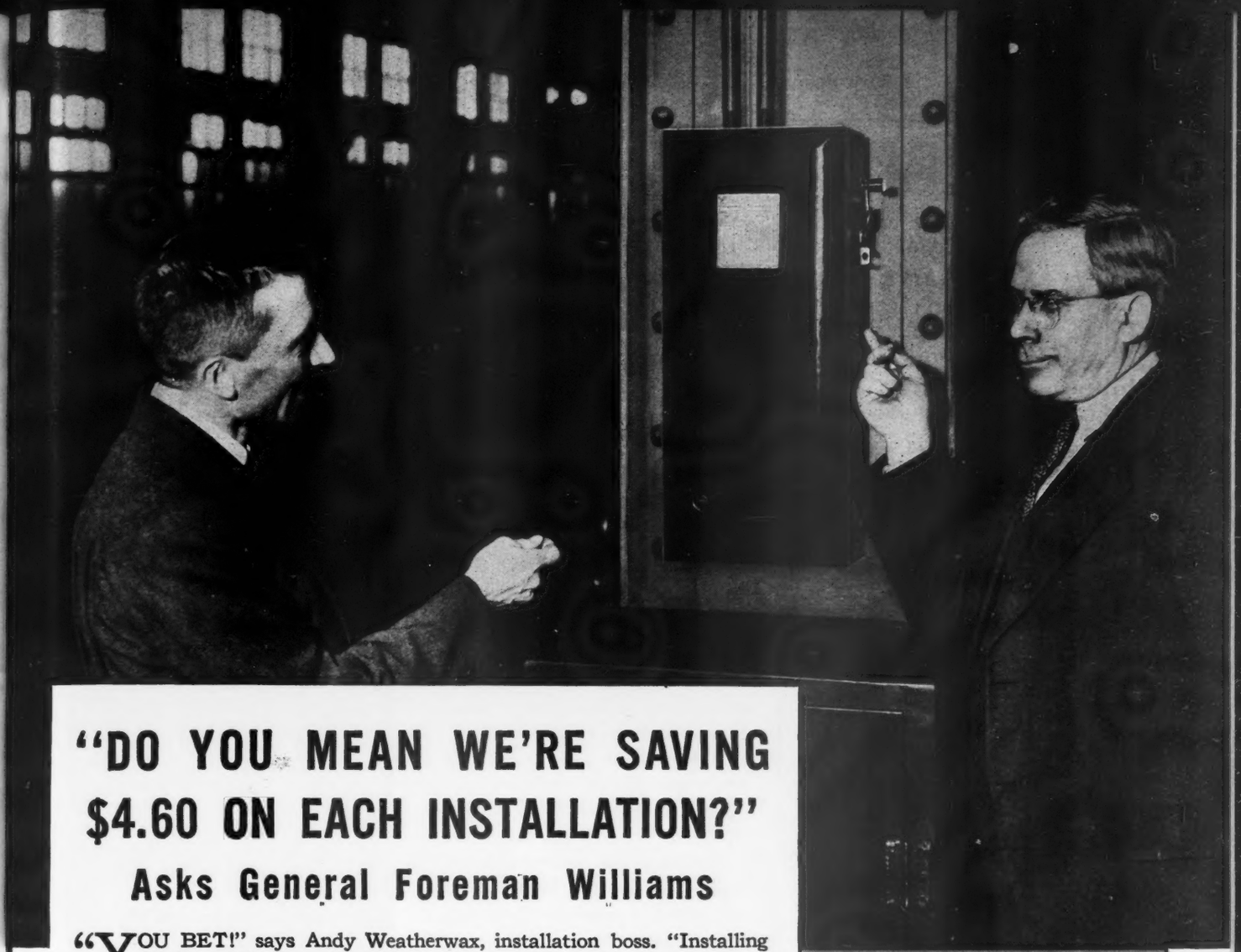
"Hallowell" Steel Tool Stands—Steel Trucks and Lift Truck Platforms—Steel Bench Legs—Unbrako Socket Head Cap Screws and Unbrako Hollow Set Screws.

STANDARD PRESSED STEEL CO.

BRANCHES: BOSTON, CHICAGO, DETROIT

JENKINTOWN, PENNA.

BRANCHES: INDIANAPOLIS, SAN FRANCISCO, ST. LOUIS



"DO YOU MEAN WE'RE SAVING $4.60 ON EACH INSTALLATION?"

Asks General Foreman Williams

"YOU BET!" says Andy Weatherwax, installation boss. "Installing a G-E combination switch* instead of separate devices saves us $4.60 in labor and material costs. You see, with this switch you simply mount the case, connect the motor, and hook up the power leads. There you've got all the control that you need for a single motor—wired and ready to operate."

Thanks, Andy. We're glad that you're showing Mr. Williams how to save money this way. A number of people have been writing to us about it, saying that the G-E combination switch is the most economical way that they've found to control a single induction motor.

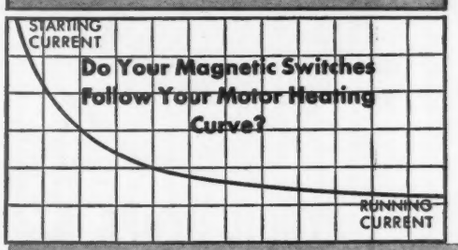
Besides the advantage that Andy speaks of, the G-E combination switch makes provision for the safety of operators and equipment The case is so interlocked that it cannot be opened while power is supplied to the magnetic switch—protecting operators from accidental contact with live parts. And the same overload relay is used as on other G-E magnetic switches—a relay which follows closely the motor-heating characteristic. It shuts the motor down as soon as a dangerous operating temperature is reached—but not until then. This saves many costly shutdowns and delays.

Why not benefit from the advantages offered by this switch which combines manual and magnetic control? Send in the coupon for your copy of the new publication describing these switches and modifications for short-circuit protection and circuit testing. General Electric Company, Schenectady, New York.

* The G-E combination switch comprises a manual disconnecting switch and a magnetic switch providing overload protection—mounted and wired within a pressed-steel enclosing case.

GENERAL ELECTRIC

FULL PROTECTION ALL THE WAY WITH G-E MAGNETIC SWITCHES



General Electric Company
Dept. 6—201, Schenectady, N. Y.

I should like to know more about G-E combination switches. Please send me your new Bulletin GEA-1587B.

Name.....

Company.....

Address.....

080-94

WIRE

Round—Flat—Half Round
Straightened and Cut
Shape Wire

HIGH CARBON SPRING
LOW CARBON BASIC AND
BESSEMER OIL TEMPERED
WELDING WIRE RODS AND COILS

●

Sizes ½" to No. 40 WM Gauge (.007)—All Finishes

●

Wire for Practically All Purposes and Requirements also SCREEN WIRE CLOTH

●

Highest Quality and Service Guaranteed

●

Established 31 Years

IRON STEEL QUALITY WIRE "SENECA"

The Seneca Wire & Mfg. Company
Fostoria, Ohio

Representatives and Warehouses in practically all principal cities

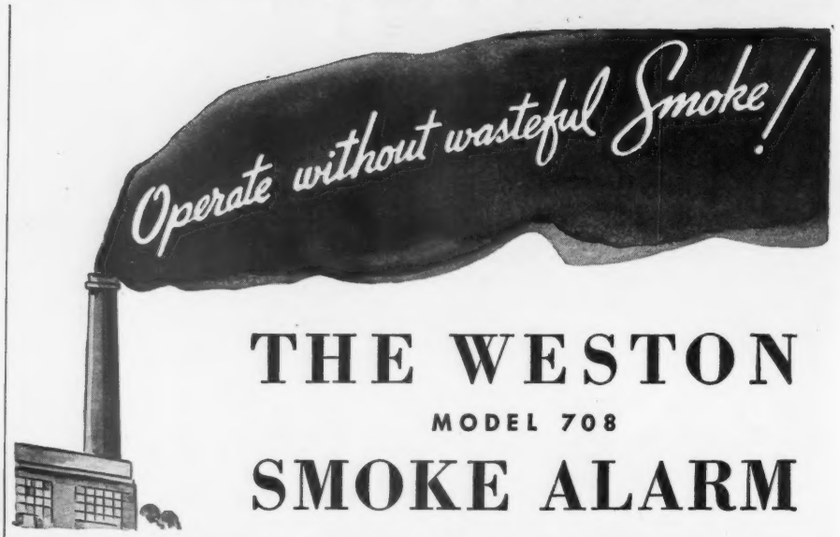
PYROIL STOPS CORROSION

Recognized as of decidedly great importance is improved Pyroil's definite ability to inhibit corrosion on bearings and metals—to stop destructive corrosive action. In addition, Improved Pyroil increases film strength of lubricants as much as 90%. Reduces surface tension, lowers temperatures, increases power output.

Highly interesting laboratory and field data supplying facts of Improved Pyroil's important functioning, sent FREE on request. No obligation. Manufactured and Guaranteed by Pyroil Company, W. V. Kidder, Founder, 245 LaFollette Ave., LaCrosse, Wis., U.S.A.

Every container Bears this Signature

Founder



THE WESTON

MODEL 708

SMOKE ALARM

sounds a warning every time smoking occurs . . .

permits corrections to be made before losses occur

Today, a badly adjusted burner or stoker may be the cause of smoke. Tomorrow, it may be poor fuel, or a sudden change in atmospheric conditions. In the ordinary power plant it is impractical to eliminate all these variables in advance.

But you can operate without wasteful smoke . . . keep your record with the community clean . . . if you have prompt warning—night or day—the instant smoking occurs. Then it's easy to put your finger on the immediate cause, and make corrections, before serious damage is done.

The WESTON Model 708 Smoke Alarm puts an alert "electric eye" on the watch within your stack or stack flue. It sends a warning signal whenever smoke density exceeds the level you set as a permissible maximum. If you wish, you can use auxiliary equipment with the Model 708 to provide a chart record of smoke duration and intensity.

The Model 708 Indicating Smoke Alarm is inexpensive, compact and easy to install. Employs the lifetime WESTON *PHOTRONIC Cell. Relay on panel always indicates amount of smoke passing up the stack.

Small industrial power plants, as well as multi-boiler central stations, look to the WESTON 708 for protection and economy in avoiding smoke losses. Why not write for full particulars . . . Weston Electrical Instrument Corporation, 628 Frelinghuysen Avenue, Newark, New Jersey.

*PHOTRONIC—a registered trademark designating the photoelectric cells and photoelectric devices manufactured exclusively by the Weston Electrical Instrument Corporation.

WESTON *Instruments*

Your own needs will be permanently satisfied by K & M Asbestos Products. They are a complete line, specialized to meet the requirements of every plant. Their greater economy, uniformity and durability are the result of rigid quality-control, from raw fiber to finished product, and more than 60 years' pioneering development of insulation and building materials.

A few of K & M Specialized Products:

- Asbestos Cement Sheets in corrugated and flat form
- Asbestos Packings and Gaskets
- Asbestos Pipe Insulation in sections
- Asbestos Insulation in sheets and blocks
- Asbestos Insulating Cements
- Welding Electrodes (Celto)
- "Featherweight" 85% Magnesia Pipe Insulation, Blocks and Lagging
- Refractory Cements, dry and plastic

Don't let machinery noises handicap your phone service!

Important instructions are often misunderstood because the clatter and roar of nearby machinery drowns the speaker's voice.

The modern answer is the Burgess Acoustic Communication Booth lined with Burgess Acousti-Pad. This patented lining blots up extraneous noises so effectively that no door is needed. The combination of perforated metal and acoustic absorbent prevents echoes and reverberations. It produces a zone of quiet which makes telephone conversations easy in the noisiest places. Every noisy plant needs one or more Burgess Communication Booths for efficient handling of telephone service.

Burgess Model 201 Booth for noisy mills and factories.

Learn how factory phone service may be improved. Investigate the Burgess Booth—mail the coupon for Bulletin 126.

Licensed under C. F. Burgess Laboratories, Inc., Patents.

Clip this coupon NOW!

Burgess Battery Co., Dept. F
111 W. Monroe St., Chicago, Ill.

Please send specifications and prices of Burgess Booth.

Name.....

Firm.....

Address.....

City.....State.....

For leather, rubber and composition belts, use the old favorite giant, red-labelled bar of Dixon's Solid Belt Dressing. Nothing better to prevent belt slip and preserve belt life. Quick and easy to apply — just hold it up against the running belt.

Use Dixon's Paste Belt Dressing, the water-proofing belt preservative, to make belts cling by restoring pliability without imparting a sticky, dust-catching surface. Nothing like it for manila transmission ropes—keeps fibres flexible, increases traction, waterproofs, prevents rotting. Applied running or idle, from collapsible tubes or from cans, with paddle or brush.

At Supply Houses Everywhere.
Booklet 0-44 gives complete information.

JOSEPH DIXON CRUCIBLE CO.

Established 1827 — D X N TRADE MARK — Jersey City New Jersey

DIXON'S GRAPHITE PRODUCTIONS

SEND FOR CIRCULARS

SHEPARD NILES

DIRECT WORM DRIVE

Electric Hoists

1/4 TO 6 TONS CAPACITY

CLOSE HEADROOM, AUTOMATIC LUBRICATION, ROPE OR PUSH BUTTON CONTROL, ANTI-FRICTION BEARINGS

WRITE FOR BULLETIN

SHEPARD NILES CRANE & HOIST CORP.

384 Schuyler Ave., Montour Falls, N. Y. • Export: 111 B'dway, N. Y. C.

MOST COMPREHENSIVE LINE OF CRANES & HOISTS

"McCASKEY *Controls Give Us* COSTS and PAYROLL DISTRIBUTIONS *Without a Single Posting"*

They would do as much and more for you. Your costs and payroll distributions, production follow-up and allied data would be available almost simultaneously with the progress of manufacturing operations with McCaskey methods. Read the recent comments of a nationally-known manufacturer:

> "We have found nothing to equal McCaskey Controls for obtaining production, payroll, cost, and routing data, quickly and accurately. Our installation saves the time of 1½ to 2 clerks, cuts the cost of forms, and eliminates books, saving altogether from $1900 to $2500 annually. This repays the first investment several times a year.
> "Keeping track of penalties for rejections or spoilage, unproductive labor time, and tool making costs saves several thousand more yearly. The local McCaskey representative rendered valuable assistance in working out our systems."

McCaskey Controls are designed to meet your specific requirements on proven basic principles, described in the following pamphlets. They were prepared for your information. Which ones shall we send you?

- PAYROLL AND COST DISTRIBUTIONS WITHOUT POSTING
- NO LOST TOOLS ANY MORE
- FIX TOOL RESPONSIBILITY
- PERPETUAL INVENTORY SIMPLIFIED
- SIMPLIFIED PRODUCTION CONTROL

THE McCASKEY REGISTER COMPANY, ALLIANCE, OHIO

McCASKEY INDUSTRIAL CONTROLS

PRODUCTION • INVENTORY • MAINTENANCE • TOOLS • COSTS • PAYROLL

Genasco

STANDARD TRINIDAD

Built-up Roofing

Look over the actual performance records of Genasco Standard Trinidad Built-up Roofing on industrial plants and you will find that they have been giving long trouble-free protection from the weather under all climatic conditions.

Genasco Standard Trinidad Built-up Roofings, constructed with alternate layers of Genasco Trinidad Lake Roofing Asphalt and Genasco All-rag Felts, have proved their superiority in resisting roofing's worst enemy—the destructive ultra violet rays of the sun.

If any of your factory buildings require re-roofing, or you are planning new structures, you can get a quality roof which will be more economical in the long run by specifying Genasco.

Write for our free book

"FOR YOUR ROOF"

—it's yours for the asking.

THE BARBER COMPANY, INC.

Philadelphia New York Chicago St. Louis

REMOTE INDICATING

MAGNETIC COUNTER

This Veeder-Root (Remote-Indicating) Magnetic Counter reports machine output from factory to office. Mechanical contacts on the machine in the shop make and break the electrical circuit which operates the counter, wherever located.

The Magnetic Counter is only one of hundreds of standard Veeder-Root Counters that supply modern management with records on which to base production control, planning, scheduling and incentive payment systems.

Without obligation—write for the booklet.

"To Count Is To Control."

VEEDER-ROOT INC.

HARTFORD, CONNECTICUT

SIZE IT UP!

AnyWayYou Look At It A Bunting Bar Is Better . . .

Bunting Bronze Cored and Solid Bars are 13" long. They cut without waste into multiples of standard bearinglengths. 130 stock sizes.

● Over 600 stock sizes Bunting Bronze Standardized Bearings completely machined and finished. Stock bearings for all electric motors 1/40 hp to 60 hp. Catalogs on request.

● Let us quote on your special requirements.

• •

The Bunting Brass & Bronze Company . . . Toledo, Ohio. Branches and Warehouses in All Principal Cities.

BUNTING Quality

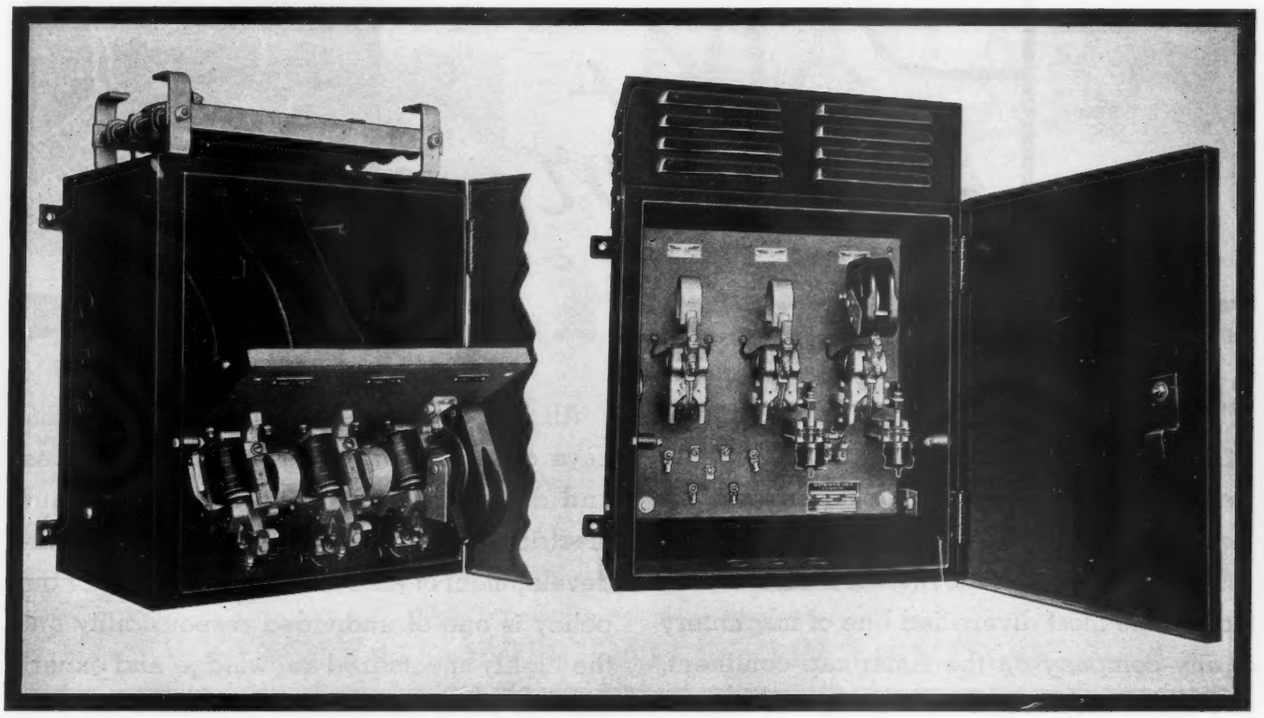
BRONZE BUSHINGS • BEARINGS

MACHINED AND CENTERED BRONZE BARS

ANTI-FRICTION BABBITT

NEW EC&M MILL TYPE STARTER

for 5-25 HP, 230 Volt Motors



NOW—but ONE UNIT for 5-25 HP range

EC&M scores again with a remarkably new design, mill type starter. It not only provides a standardized unit that is readily adaptable to a wide range of motor sizes, thereby reducing the maintenance problem to a minimum, but also is outstanding in simplicity and accessibility. The electrical men of industry who have seen this new unit have been greatly impressed by the ease with which acceleration time can be adjusted, the accessibility of this adjustment, the selection of the resistors to meet these horse power requirements and the method of completely exposing all connections.

When desired, this starter can be supplied with main line knife switch, overload relays or similar features. When this unit is used with adjustable speed motors, it can be furnished with field acceleration relays, field failure relays, etc. Full details of the EC&M Mill Type Starter will be sent upon request. Write for this information today.

ADVANTAGES

- Compact, self-contained unit arranged for wall mounting.
- Panel swings forward, making all parts easily accessible.
- New Type RD Mercury-type Acceleration Relays.
- Quickly adjustable for ½ to 2 seconds per acceleration step.
- Reconnection of resistors only requirement to meet wide horse power range.
- Main Line Contactor of ***LINE-ARC*** Design, giving scientific control of the arc—long life of contacts and keeping arc from arc shields.

The ELECTRIC CONTROLLER & MFG. CO.

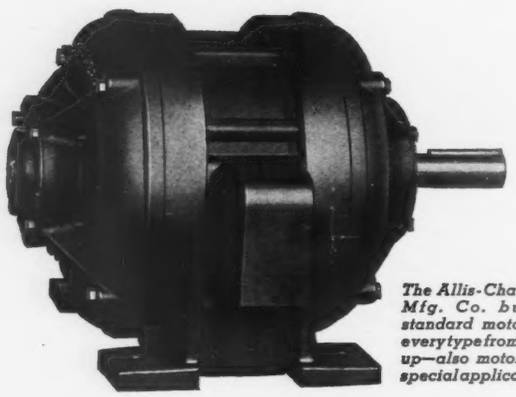
2700 East 79th St., CLEVELAND, OHIO — Offices and Agents in Principal Cities

HEAVY DUTY MOTOR CONTROL for... BRAKES • LIMIT STOPS • LIFTING... E&M ...CRANES • MILL DRIVES and MACHINERY ...MAGNETS • and WELD TIMERS

THE Proprietor EATS IN ANOTHER RESTAURANT

IT'S an old quip . . . about the restaurant proprietor who steps out for his lunch. But its implication is deadly—he doesn't eat his own food.

We manufacture motors. We also manufacture the most diversified line of machinery of any company on the American continent, and that machinery is driven by the motors that we build . . . by Allis-Chalmers motors.



The Allis-Chalmers Mfg. Co. builds standard motors of every type from 1 hp. up—also motors for special applications

All the engineering skill and ability that have gone into the development of that vast and distinguished line of mechanical and electrical machinery have contributed to the development of Allis-Chalmers Motors; for our policy is one of undivided responsibility and the highly specialized knowledge and experience of every department is exchanged with that of every other department where it may have any bearing. It is from this wide and varied background that we designed and developed Allis-Chalmers Motors specifically for industrial application.

Allis-Chalmers Motors excel because they are the sturdiest motors on the market today—bar none. And they are the most profitable motor buy on the market today—bar none, because their great mechanical and electrical strength reduces maintenance costs to the minimum and extends their life beyond that of all less sturdily constructed motors.

MOTOR DIVISION

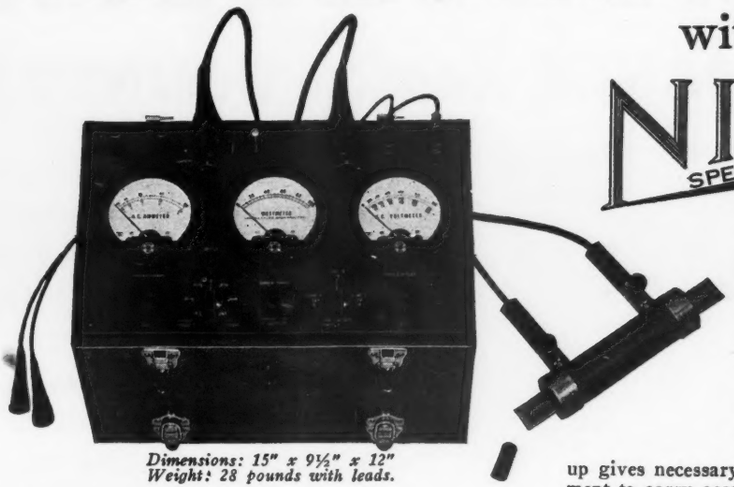
ALLIS-CHALMERS

FOR EVERY PURPOSE

MILWAUKEE WISCONSIN

CHECK POWER CONSUMPTION–STOP WASTE with a MODEL 555

NIAGARA SPEED TEST SET



Dimensions: 15" x 9½" x 12"
Weight: 28 pounds with leads.

This instrument is designed for a broad field of AC industrial testing;—single phase and polyphase—Volts, Amperes and Watts, readily converted into Volt-amperes and Power-factor. Frequency 25 to 133 cycles.

Model 555 Niagara SPEED Tester is compact—complete. The one carrying case contains all essential needs for an electrical test. One hook-up gives necessary readings. The bottom cover forms a compartment to carry accessories for connecting meters into the test circuit —heavy current leads, potential leads and "dummy" fuses.

Meters used are 4 inch Hickok Meters.

One firm of engineers that makes business surveys says: "We have used our Niagara SPEED Test Set for the past three years and it continues to give us very satisfactory service. We have in this time tested thousands of motors."

Ranges are as follows:
VOLTMETER: range 0-150, 300 and 600.
AMMETER range 0-7.5, which is extended by a current transformer built into the meter circuit to 15, 37.5, 75 and 150 amperes maximum.
WATTMETER ranges: lowest range 0-500 watts, highest to 0-120 K.W. in consecutive steps.
External current transformers can be used to increase ampere and watt ranges.

Write for complete information and prices.

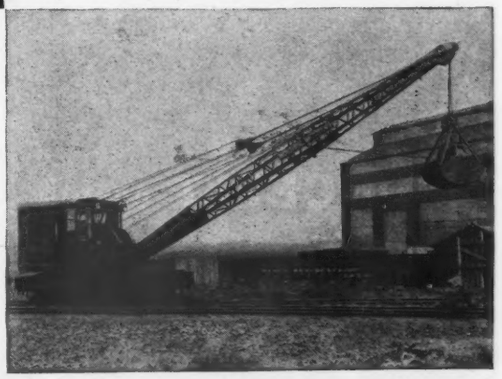
NIAGARA ELECTRICAL INSTRUMENT CO.

Division of Hickok Electrical Instrument Co.

No. 1 W. Genesee St. BUFFALO, N. Y.

OLD ENOUGH TO VOTE-- still working two shifts

Compare the modern Industrial Brownhoist Diesel-powered crane below with the 22-year old machine shown at the left. More and more crane owners are turning to Diesel or gasoline power because of these definite advantages (1) lower operating costs (2) time saved starting and laying crane up (3) faster, sustained travel speeds (4) one-man operation.



A west coast timber company purchased an Industrial Brownhoist in 1914 and another a year later. Loading cars and barges, sorting timbers, digging out the log pond with clamshells and switching cars . . . these cranes have worked steadily ever since.

Improvements in design, speed and ease of operation are constantly being made in our cranes but the time-tested standards for materials, workmanship and rugged dependability never vary.

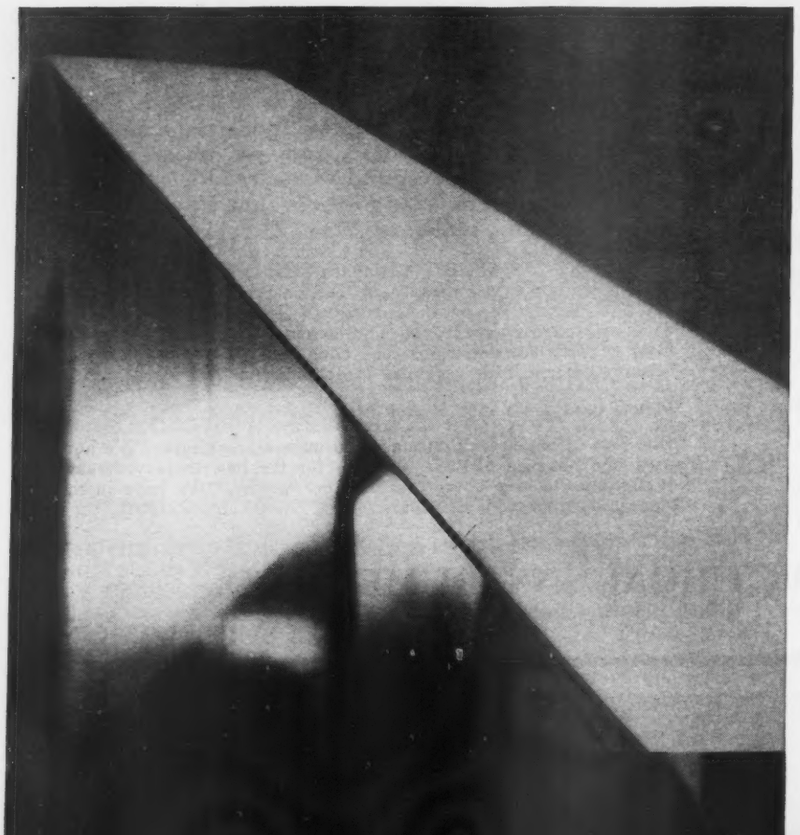
Industrial Brownhoist railroad cranes are built in capacities of 10 to 200 tons; crawler cranes from 6 to 25 tons capacity. There is a type and size exactly suited to your work.

GENERAL OFFICES BAY CITY, MICHIGAN

INDUSTRIAL BROWNHOIST

NEW YORK, PHILADELPHIA CLEVELAND, CHICAGO

THEY USE MONOBELT.. WHEN PERFORMANCE *Really* COUNTS!



This main drive in the power plant of a large manufacturing concern, where power trouble means an entire plant shut-down, is a definite tribute to unfailing MONOBELT performance.

Here Monobelt maintains a capacity load, hour after hour, day after day. The high coefficient of friction found in Monobelt is actually "built" into the belt during manufacture. This is accomplished by successive steps in the preparation of the leather and in the construction of the belt.

Monobelt's coefficient of friction is not merely the result of some surface treatment, it is inherent in the belt.

Write today for specific information.

ALEXANDER BROTHERS, INC.
Philadelphia, Pennsylvania

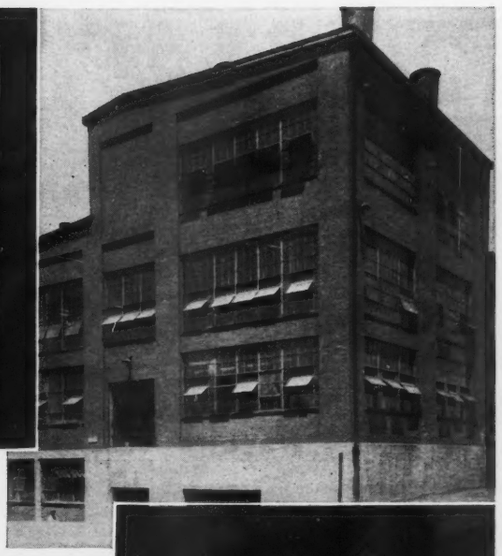
MONOBELT operates regular drives with consistent efficiency

EQUIP YOUR DRIVES WITH MONOBELT

Alexander Brothers INC.
PHILADELPHIA PENNSYLVANIA
Sign of Merit SINCE 1867

MEMBER POWER TRANSMISSION COUNCIL

TITANIUM PIGMENT Another.. CLARAGE Installation



Edgemoor Boilers, Laclede Stokers and Clarage Forced and Induced Draft Fans are used in this Power Plant of Titanium Pigment Co., St. Louis, Mo.

(Above) One of two Clarage Type FD Forced Draft Blowers, each delivering maximum of 21,000 c.f.m. Both equipped with Vortex Control.

(At right) One of two Clarage Type RT Induced Draft Fans handling 89,000 c.f.m. exhaust gases at 550° F.

Modern MECHANICAL DRAFT EQUIPMENT

There is no substitute for experience and continual product improvement.

For almost a quarter century, we have worked hand in hand with leading power plant engineers, with leading boiler and stoker manufacturers —developing mechanical draft equipment to meet every service condition.

Designed by specialists, built by experts, Clarage Mechanical Draft Fans give you the highly-efficient, absolutely dependable air control so vital to the production of power with utmost economy.

For instance, the forced draft blowers installed in this Titanium Pigment plant are equipped with VORTEX CONTROL (patented Clarage feature) which provides ANY desired volume regulation, the fan operating at constant speed. You save substantially in motor and control costs, then in operating cost.

Ask any power plant authority for an unbiased opinion on Clarage design and construction. Or write us for any desired data.

SPECIFY CLARAGE for
COMPLETE AIR CONDITIONING
VENTILATION
HEATING
COOLING
MECHANICAL DRAFT
FANS & BLOWERS FOR INDUSTRIAL NEEDS

CLARAGE FAN COMPANY • Kalamazoo, Mich.
SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES

MACWHYTE SLINGS are safer... easier to handle

Patented braided construction increases flexibility --resists kinking --speeds loading

Only Macwhyte Slings have this special construction—*wire rope spliced endless and then braided.*

That's why Macwhyte Braided Slings are the most flexible wire rope slings you can use—and safest, too.

They hug the load — but straighten out quickly when released. They resist kinking and spinning. They handle so easily, Macwhyte Braided Slings speed up loading and cut production costs.

Two types: ATLAS, with a round braided body — DREW, with a flat belt-like body. Specially built for every type of materials handling.

No. 227

Write Dept. FM-12 for descriptive folders
MACWHYTE COMPANY, Kenosha, Wis.

MACWHYTE WIRE ROPE Slings
ATLAS · DREW · MONARCH

PRECISION

SELF-ALIGNING DOUBLE-ROW

"NORMA-HOFFMANN"

BALL & ROLLER BEARINGS

A complete line of self-aligning ball bearings, in extra-light, light, medium, heavy, extra wide and adapter types * * * * also a comprehensive line of self-aligning roller bearings * * * * all types with heavy-duty bronze retainers of superior construction.

Ask for Catalog and Engineering Counsel

NORMA-HOFFMANN BEARINGS CORPN. - STAMFORD, CONN. U.S.A.

When *Speed* is essential

Speedy painting is essential where interruptions during business hours mean delays in production schedules, or loss of cash receipts.

The ease of painting or spraying MURAL-TONE, and the fact that it dries in forty minutes, makes it an ideal paint for walls and ceilings of factories, stores, garages, laundries, etc.

MURAL-TONE enables the painter to do surprisingly large areas quickly. One coat covers and hides on most surfaces, but if a second coat is desired it can be applied in a few hours.

MURAL-TONE is a high-grade casein paint made from true paint pigments. Has no unpleasant paint odors. Colors are clear. White is 90% light reflective. No sizing is required, unless faulty surface conditions exist.

Send for free samples. Make your own tests. No obligation. Address: THE MURALO CO., INC., (Founded 1894), 576 Richmond Terrace, Staten Island, New York. *Branches:* Atlanta — Boston — Chicago — San Francisco.

Founded 1894

BETTER WHITE BETTER LIGHT

mural-tone

The Money-Saving Paint in the Orange Can

Dries in forty minutes

•

One coat covers and hides on most surfaces

•

Adheres to unseasoned plaster and cement

Will not lime-burn

•

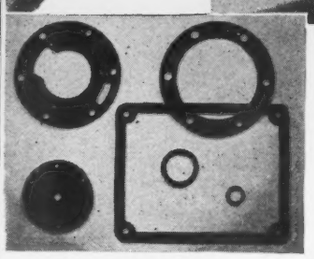
1 gallon yields 1⅔ gallons of paint

•

Cuts costs as much as 25%

A MURALO PRODUCT

RESISTANCE!



Above: GARLOCK 353 Oilblack Rubber Sheet Packing. Below: GARLOCK 953 Gaskets, cut from GARLOCK 353 Sheet.

Garlock 353

OILBLACK RUBBER SHEET

SCIENTIFICALLY compounded by GARLOCK to *resist the deteriorating action of oils*, GARLOCK 353 gives exceptionally long and dependable service against heavy and light oils. Also is recommended for hot or cold water, saturated steam, ammonia or alkali solutions. Try GARLOCK 353 in your plant; it will save you time and trouble . . . will help you keep down maintenance costs.

THE GARLOCK PACKING CO.
Palmyra, New York

In Canada: The Garlock Packing Company of Canada, Limited, Montreal, Que.

GARLOCK

Carrier Unit Heaters

HOW much of your heating expense is caused by "overhead"—that non-productive area between the working level and the ceiling? Plenty when you heat with pipe coils and direct radiation!

By directing heated air exactly where needed, Carrier Unit Heaters reduce this waste to a minimum, improve working conditions, and frequently save up to 35% in fuel costs alone.

Built to Endure

The "accordion" type Aerofin coil assures free expansion and contraction and is an exclusive Carrier development—*not a modified automobile radiator.* Headers—both supply and return—are non-ferrous. Dirt cannot clog the coil to impair radiation—and every coil is built to withstand 200 pounds working pressure. Fans, motors, coils, brackets . . . in fact *every* part used in Carrier Unit Heaters is built to endure.

Easily Installed — Quiet in Operation—Designed Especially for Industrial Use

Carrier Unit Heaters can be suspended from ceiling or ceiling trusses, or attached to walls—whichever is most convenient. Their quiet, vibrationless operation and attractive design make them just as desirable where appearance must be considered, as where economy and efficiency are of foremost importance.

Why Carrier?

Efficient heating is primarily a matter of warm air diffusion. And Carrier is thoroughly qualified to design and build equipment for space heating. Carrier—who 25 years ago this month *invented* air conditioning*. Carrier—with 46 years experience in product conditioning and commercial refrigeration. Carrier—who has had more than 15 years' experience in designing and installing heat diffusion equipment for buildings of every size, shape and style.

Immediate Installment

By calling your local Carrier dealer now, you can still enjoy the benefits of Carrier Unit Heating this winter. Get in touch with him today—learn how *you* can get more effective heat, longer service at lower cost with Carrier Unit Heaters and Heat Diffusers. Or, mail coupon below.

*Willis H. Carrier in 1911 founded the new industry when he disclosed the scientific laws of air conditioning to the American Society of Mechanical Engineers and began making air conditioning installations.

Carrier
Air Conditioning

CARRIER CORPORATION, Desk 608
850 Frelinghuysen Ave., Newark, N. J.

Please send me information on Carrier Unit Heaters and Space Heaters for ☐ Factories; ☐ Warehouses.

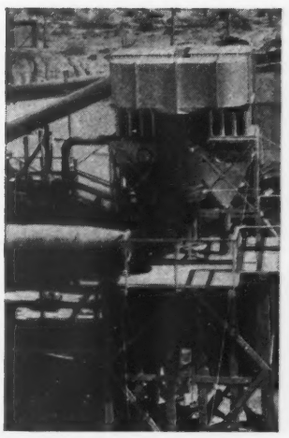
NAME.....

COMPANY .....

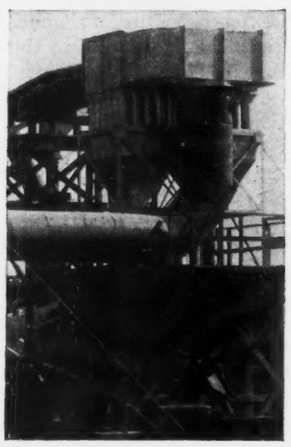
ADDRESS.....

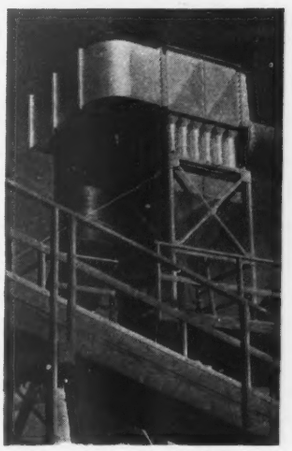
ONCE AGAIN
Baker
Leads the way
Baker
The new Baker SWIVEL-FORK Truck provides a new low cost method of loading, unloading and storing sheet steel. Write for complete details.
BAKER INDUSTRIAL TRUCK DIV.
of The BAKER-RAULANG COMPANY
2178 West 25th Street, Cleveland, O.
Baker
TRACTORS
TRUCKS

Dust



A nuisance or a product? In either case Multiclone collection combines low cost operation with high efficiency and simplicity. A dry process of intensified centrifugal separation and collection, with no parts to clean, repair or replace. Multiple tube construction permits installations of any capacity and easy additions when expansion is needed. All-metal, fireproof, to handle hot or cold gases. Multiclones collect finer particles than any other centrifugal type of separator. Can be erected by regular factory help.





Send for new bulletin.

WESTERN PRECIPITATION COMPANY

1016 W. Ninth St., Los Angeles • 405 Lexington Ave., New York
PRECIPITATION CO. OF CANADA, LTD., Dominion Square Bldg., Montreal
PEEBLES SPRAY DRYERS • COTTRELL ELECTRICAL PRECIPITATORS
Specialists in Dust and Fume Control for more than a quarter of a century

DEPARTMENT STORES RAILROADS PRINTERS BANKS
SHOE MANUFACTURERS BOX MAKERS WHOLESALE GROCERS
LITHOGRAPHERS CLOTHING OIL COMPANIES NURSERIES
LAMP MANUFACTURERS PARTS MANUFACTU SEEDS
AUTOMOBILE MANUFACTURERS BAGS
NEWSPAPERS PUBLISHERS CAPS
STORAGE COMPANIES RUG MAKERS
NOVELTY MANUFACTURERS FOODS
ART SUPPLY HOUSES FIXTURE MANUFAC
MOVERS AUTOMOBILE ACCESSORIES APER
ICE COMPANIES BAKERIES MOULDING MFG CHAIN STORES

WHO USES **PACORD?**

In the factory and industrial field, ever increasing numbers of firms are reducing tying and shipping costs, increasing efficiency, with Pacord, the *new kind* of twine. Pacord is a Manila twine with kraft paper covering. It is easier to tie with, neater, stronger and more economical to use. Write today for samples and literature.

TUBBS CORDAGE CO. San Francisco
200 Bush St.

PORTLAND CORDAGE CO.
Portland New York Seattle

Business Leaders—Executives, Engineers, and Production Managers—Are Releasing Billions for Industrial Expansion

McGraw-Hill Editors See Uprise in the Heavy Industries

TOP EXECUTIVES OF AMERICAN BUSINESS ARE LOOSENING THE PURSE STRINGS

GLENN GRISWOLD
Editor
Business Week

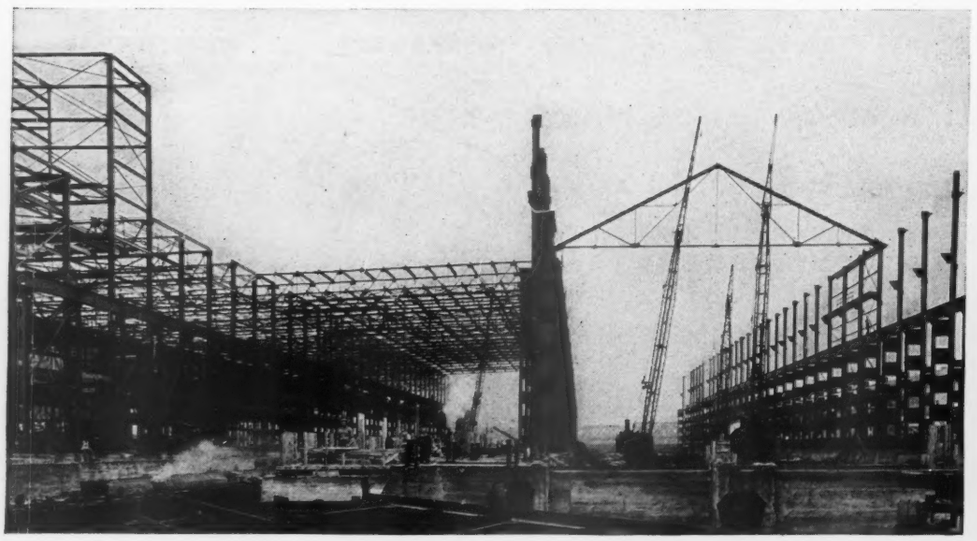
Business is confidently basing its plans for the next year on the premise that the general trend will be definitely upward. Evidently nothing short of a world catastrophe can stifle the forces that are pressing inexorably toward a greater volume and velocity of business.

Every business index tends to confirm this conclusion. And it is to be remembered that the business expansion we have experienced in the last two years has in most cases amounted only to the almost irreducible minimum necessary to meet the urgent demand of consumptive wants. We have only begun to fill the accumulated wants of one of the longest and worst periods of depression in our history. ***Unprecedented high records will be set next year in the sale of consumer and industrial goods.*** The BUSINESS WEEK Index of Business Activity confirms the opinion that there is sufficient room for this anticipated expansion. While all business indices reveal the upward trend, it is significant to observe that BUSINESS WEEK's index stands at but 77% of normal and probably will average about 75% for the year 1936.

Any appraisal of the outlook for business must take into consideration the existence of the American urge to launch new enterprises. There has been insufficient stimulus to this impulse and practically nothing thus far has been contributed by these new developments towards industrial recovery. A tremendous unfilled market anxiously awaits their growth.

Business men have yearned for a new industry which would perform the recovery miracle accomplished by the automobile and the radio. Two such industries are actively functioning today and will be responsible for a staggering total of new business next year. One such able contributor is air conditioning which holds forth untold possibilities. Another, perhaps of greater potentiality, is the building and construction fields which have increased substantially yet have not approached the levels of 1928 and 1929. In these fields, air conditioning, noise and dirt elimination and electrification promise to make the homes of America obsolete to a degree we have not known since the turn of the century when central heating, modern plumbing and electric lighting accomplished a similar revolution. The same forces are rapidly adding a great burden of obsolescence to office buildings and factories.

Whatever concern one may have for the long time economy of this country if present tendencies are continued, the prospect for the immediate future gives promise of greater activity, increased sales, business expansion and growing profits.



Construction of new industrial plants is running 50 per cent over 1935.

THE TIME IS RIGHT . . .
•
THE NEED IS EVIDENT . . .
•
THE MONEY IS AVAILABLE . . .

Let's Rebuild America

PLANT EXPANSION AS WELL AS MODERNIZED MACHINERY AGAIN IN DEMAND

L. C. MORROW
Editor
Factory Management and Maintenance

Manufacturers of durable as well as consumer goods find their sales curves rising along with the curve of general business. Higher sales call for higher production which in turn calls for plant improvement, additions, and new capacity. Management has recovered from any fears it may have had that technological development and modern machinery spells unemployment, and is going ahead with confidence in its search for more efficient equipment.

That modernization and expansion are already proceeding at a gratifying pace is indicated by a partial list of proposed industrial expenditures announced publicly since July. Of the 58 manufacturing corporations and utilities included in the list, no one announced expenditures of less than half a million. Most of the programs provide for more; for example $29,000,000 by U. S. Steel, $25,000,000 by Fisher Body, $14,500,000 by Buick, $13,000,000 by Standard Oil of N. J., $7,500,000 by Industrial Rayon, $5,000,000 by Chrysler. *A very large number of smaller organizations are planning substantial expenditures corresponding to their size.*

These expenditures are for improvements, additions, and new capacity. Part of the money will go for new buildings, *but much of it for new equipment.*

In its recent statistical issue *Factory* pointed out that over the past six years America failed to build $29 Billion worth of houses and other buildings for which a real need exists. This shortage means a potential $18,000,000,000 market for the products of the manufacturing industries. Other potential markets pointed out were for electrical appliances $16,000,000,000 — farm electrification $5,000,000,000 — central station expansion, $3,000,000,000 — machine tools $1,000,000,000 — industrial power plants $4,000,000,000 — air-conditioning equipment $1,000,000,000.

All these markets are in sight. How soon they are to become realities will depend upon the aggressiveness with which business develops them. Sales-minded organizations are planning their sales and advertising for major gains in 1937.

MODERN POWER PLANT EQUIPMENT OFFERS HUGE SAVINGS TO INDUSTRY

P. W. SWAIN
Editor
Power

Picture a field that is not itself an industry, but embraces all industries — a field responsive to every forward step in living standards, working conditions and production efficiency, a field that spends two billion dollars yearly for its raw materials — in short, *power*. This field is the total of the power-service generating equipment in America's stationary plants: central stations, (steam, hydro, and diesel) power plants in industry, large buildings and institutions.

For steam coal alone, this power field spends a billion dollars yearly. Plants outside of central stations spend another half billion for purchased electricity, in addition to the very large amounts they generate locally. Add labor, repairs and supplies, and you have a yearly total operating expenditure of at least two billion dollars for America's power services.

Of this huge sum, approximately one billion dollars, 50%, is preventable waste, in the opinion of engineers best qualified to know. This means waste in production and consumption that could be eliminated by methods and equipment already in common use by the more progressive establishments.

More than half of all the industrial and institutional power-service equipment is over twenty years old, and most of this old equipment is obsolete. Boilers operate at 50 or 60 per cent efficiency when 80 per cent is easily obtainable. Often new high-pressure boilers would give far greater gains, on top of the increased efficiency, through increased production of by-product electricity.

Building and factory heating and process systems are wide open markets for meters and controls that will eliminate the appalling wastes in application. Thousands of pumps are so wasteful and obsolete that new modern replacement units would save their cost in less than a year.

Undoubtedly the primary key to the industrial power market is the elimination of this waste by modernization. Through constant publicity industrial executives are becoming generally aware of these losses. Improving general business is bringing action, proved by rapidly mounting orders for power equipment.

LET business paper advertising be your mass production sales tool. It goes directly to those key men who control or participate in the spending of 30 billion dollars a year for business and industrial equipment and supplies. Business paper advertising talks their language. It offers them savings and betterments in their business. It cuts the cost of selling because it educates buyers on the merits and reputation of your product before your salesman calls.

McGRAW-HILL PUBLICATIONS

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42nd STREET, NEW YORK, N. Y.

American Machinist
Aviation
Bus Transportation
Business Week
Coal Age
Chemical & Metallurgical Engineering
Construction Methods
Electrical Contracting
Electrical Merchandising
Electrical West
Electrical Wholesaling
Electrical World
Electronics
Engineering & Mining Journal
Engineering News-Record
Factory Management & Maintenance
Food Industries
Metal & Mineral Markets
Mill Supplies
Power
Product Engineering
Radio Retailing
Textile World
Transit Journal

Keep the Packing Room Safe and Clean WITH VACUUM

Vacuum cleaning in the packing or shipping room has three distinct advantages: It protects the employees; it keeps dust away from the finished goods and containers, and it does the ordinary floor cleaning quicker, better and at less cost than any other method.

Spencer Vacuum Cleaning Systems, designed in many types and sizes, will clean any kind of floor, wall or ceiling surface; remove bulky materials such as sand or coal dust, and extremely light materials such as lint or powdered dust.

Spencer Systems are used to clean machinery, to clean products before painting or finishing; to remove stencils, and to pick up or hold materials during the manufacturing process.

These systems are built especially for long-life service under the most severe industrial conditions. May we send you the bulletin?

A single unit is readily piped to all floors of any building, and light-weight vacuum hose, connected to special Spencer Vacuum Tools, provides a universal one-man cleaning system.

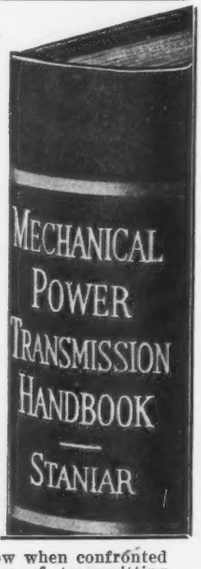
SPENCER HARTFORD

CENTRAL AND PORTABLE VACUUM CLEANING SYSTEMS

S-73

THE SPENCER TURBINE COMPANY, HARTFORD, CONN.

How to select and use *mechanical power transmission equipment*



How much has your plant invested in mechanical power transmission equipment? How much does power transmission cost you annually? This handbook brings you usable, definite information on every phase of the proper selection and efficient use of power transmission equipment—Offers facts you require to cut your power transmission costs and to secure maximum service.

Just published

Mechanical Power Transmission Handbook

By

WILLIAM STANIAR

Mechanical Power Engineer, E. I. duPont de Nemour & Co.

488 pages, 6 x 9, illustrated, $5.00

The recommendations given in this book for the selection, use and installation of transmission appurtenances are based on the author's twenty years' experience in this field of engineering. The book tells the superintendent, plant engineer, designer, millwright and mechanic exactly what they want to know when confronted with everyday problems of transmitting power mechanically. It covers latest developments in this field—including all methods—and explains how, when and where to use them so that economy of operation and efficient transmission result.

See it 10 days on approval. Send this coupon.

McGraw-Hill Book Company, Inc., 330 W. 42nd St., N. Y. C.
Send me Staniar's Mechanical Power Transmission Handbook for 10 days' examination on approval. In 10 days I will send $5.00, plus few cents postage, or return book postpaid. (Postage paid on orders accompanied by remittance.)

Name .....

Address .....Position .....

City and State.....Company.....Fac. 12–36

(Books sent on approval in U. S. and Canada only.)

The SPEARHEAD of the attack on Obsolescence

Make it

V-BELT DRIVES *by* **WOOD'S**

Smooth running, slipless, power saving WOOD'S V-Belt Drives are available in stock sizes from ¼ to 100 h.p., with at least a dozen selections of center distances for each. Sheaves of any size or capacity, or of special construction, can be designed, made and shipped in quick time.

Write for catalog!

Wood's V-Belt Drives on Air Compresors

WOOD'S PRODUCTS

Shafting, Hangers, Collars, Pulleys, Friction Clutches, Ball Bearings, Flexible Couplings, Rope Sheaves, Pillow Blocks, Belt Contactors, V-Belts, V-Belt Sheaves, and complete V-Belt Drives.

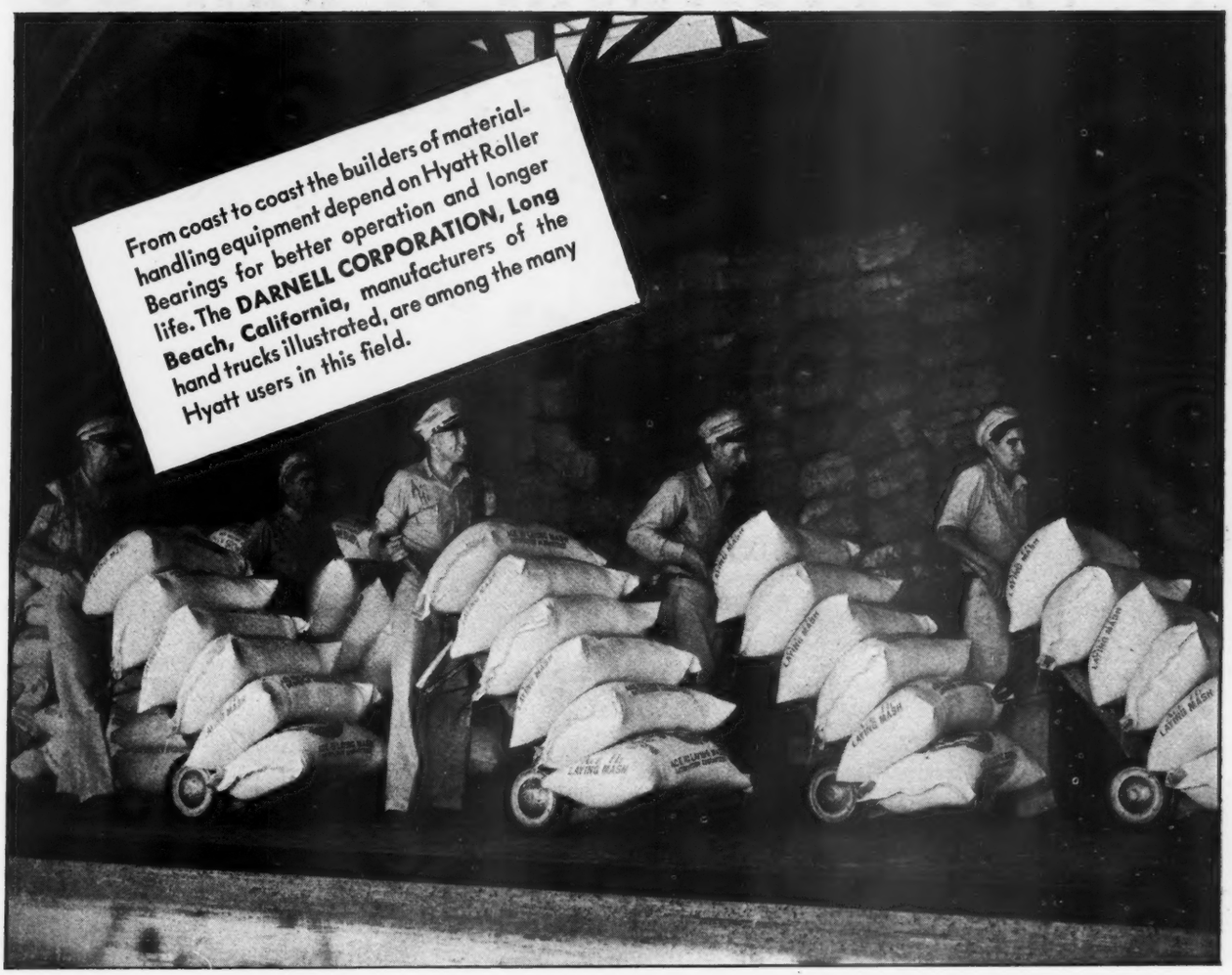
T. B. WOOD'S SONS CO.

CHAMBERSBURG, PA.

50 Church St., New York City

387-391 Atlantic Avenue, Boston

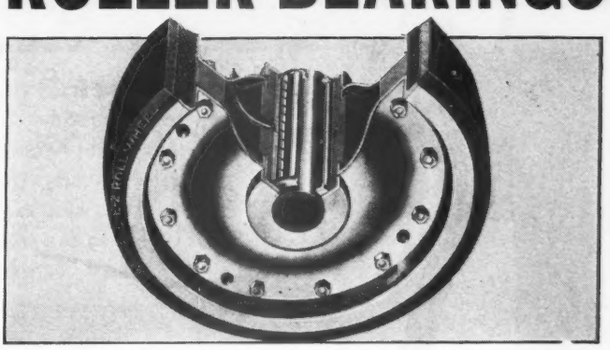
MEMBER: The Mechanical Power Engineering Associates


From coast to coast the builders of material-handling equipment depend on Hyatt Roller Bearings for better operation and longer life. The DARNELL CORPORATION, Long Beach, California, manufacturers of the hand trucks illustrated, are among the many Hyatt users in this field.

KEEPING *Several* STRIDES AHEAD...WITH

HYATT ROLLER BEARINGS

FROM the day anti-friction bearings were first applied, down through the years, each major development in machine design finds Hyatt out in front with improvements in bearing design, manufacture, performance. « And, as time goes on, the basic Hyatt characteristics of greater precision, higher capacity, and smoother operation are constantly perfected. « Not only has Hyatt kept pace in producing bearings to meet specifications, but many times has introduced application innovations. « The ever-increasing use of Hyatt Roller Bearings, year after year, indicates how such diligence is richly rewarded. Hyatt Bearings Division, General Motors Corporation, Newark, Detroit, Chicago, Pittsburgh, San Francisco.



. The Vice President of Bull Dog Electric Products Wrote This Ad .

(Quite unaware of the fact)

OFFICE MEMO

BULL DOG ELECTRIC PRODUCTS CO.
DETROIT, MICHIGAN

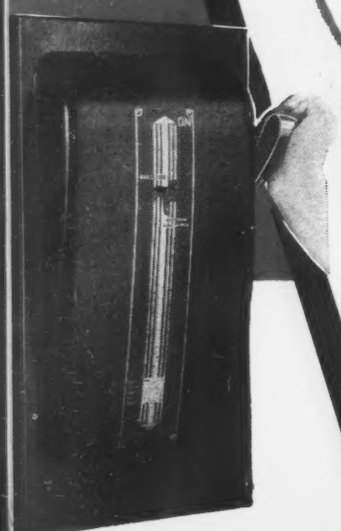
Office of Wm. H. Frank, Vice President

TO E. R. D.

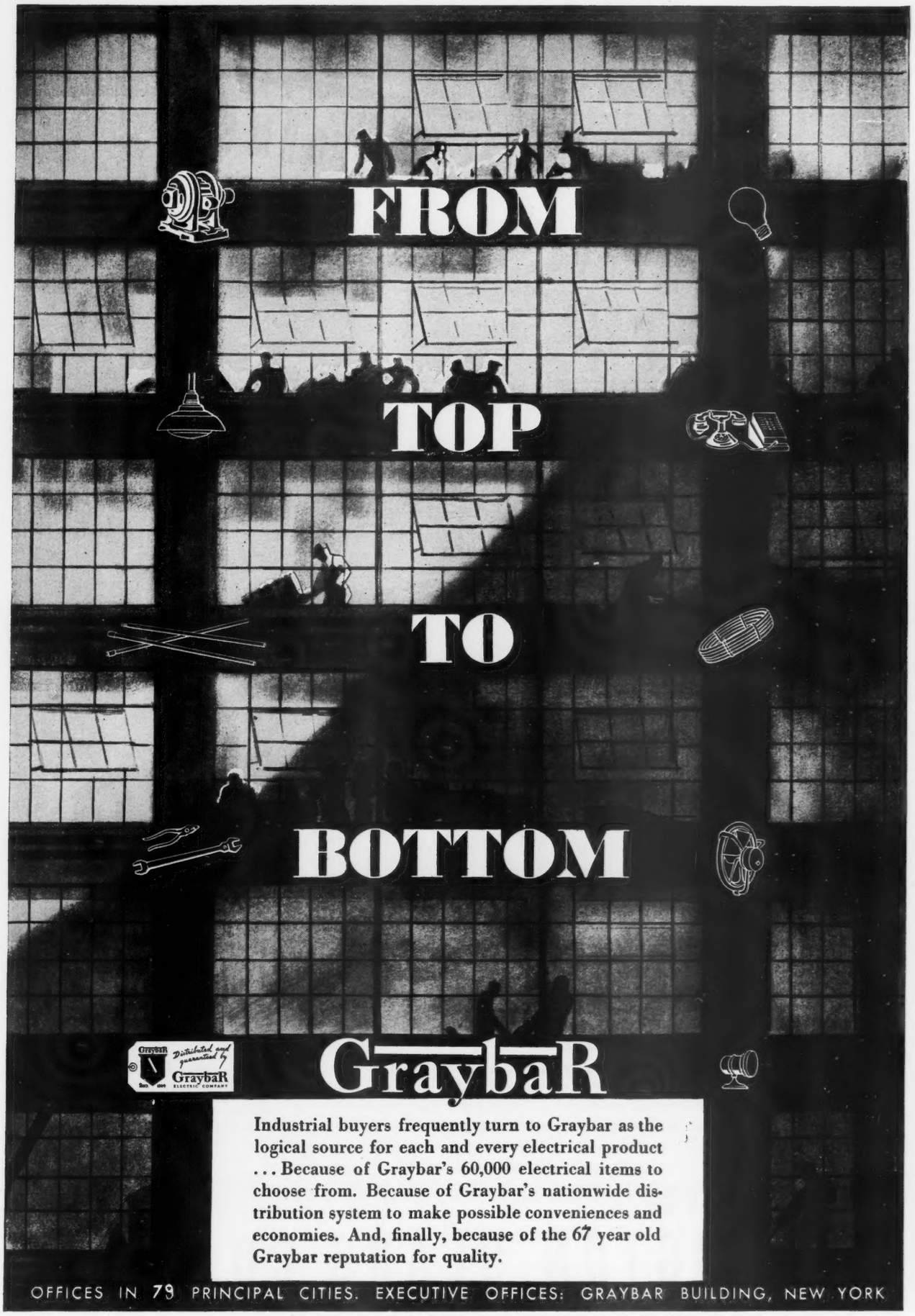
Let's prepare a message to the trade expressing our Sincere Best Wishes for a Merry Christmas and a Very Prosperous New Year -- also express our appreciation for the cooperation they have given. You might mention, incidentally, how exceptionally good the sales of Vacu-Break Safety Switches, Switch Centers, Lighting Panels, Trol-E-Duct and BUStribution have been in 1936 -- how our factory is working with increased personnel and facilities to keep production in line with the demand.

It certainly is gratifying to know that users of electrical equipment appreciate the advanced design and extra quality we are building into our products.

Sounds Good to Me—
let's run it just as is.
E.R.D.



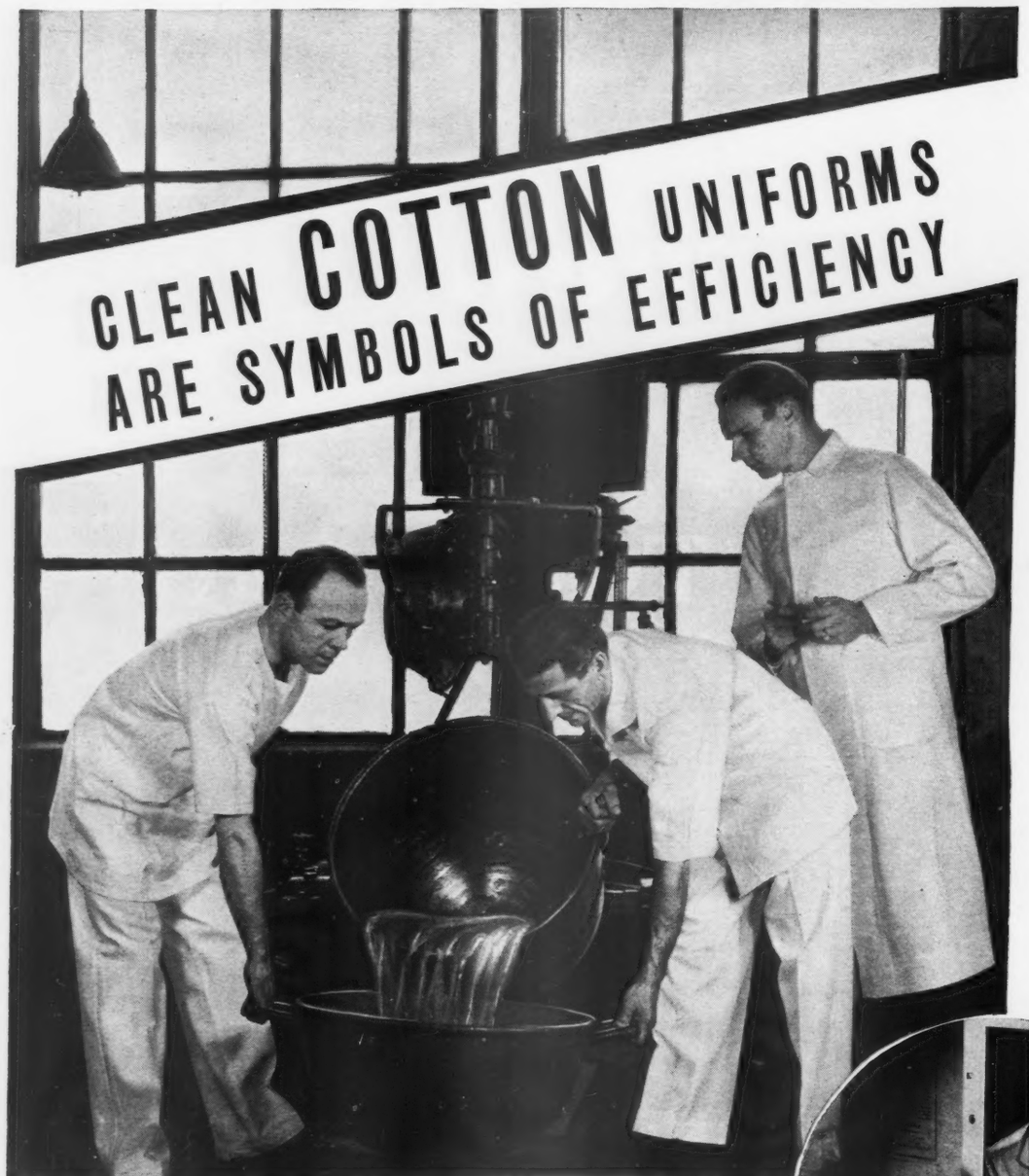
Specify BULL DOG to your Electrical Supplier



Industrial buyers frequently turn to Graybar as the logical source for each and every electrical product . . . Because of Graybar's 60,000 electrical items to choose from. Because of Graybar's nationwide distribution system to make possible conveniences and economies. And, finally, because of the 67 year old Graybar reputation for quality.

OFFICES IN 79 PRINCIPAL CITIES. EXECUTIVE OFFICES: GRAYBAR BUILDING, NEW YORK

CLEAN COTTON UNIFORMS ARE SYMBOLS OF EFFICIENCY



Because it's good business the employees of many of America's most successful concerns are as neat and clean—as spick and span—as the good things they produce or the attractively packaged articles they sell.

Not only manufacturers but independent retailers and chain stores know that clean, neat uniforms are a definite contribution to employee efficiency. Linen Supply services are now available in over seven hundred cities of the United States.

Wellington Sears Company supplies cotton fabrics for hygienic uniforms and towels—the Linen Supply industry provides facilities for laundering and delivering immaculate, sterilized uniforms and towels on a rental basis. These services by the Linen Supply industry assure the most satisfactory and economical method of providing your employees with clean garments and towels. Take advantage of them in your own business—your local Linen Supply company can tell you all about it.

COTTON TOWELS—
NOT ONLY BETTER BUT COST LESS!

For quick thorough, sanitary and economical* drying, there is no substitute for cotton towels. Fairfax towels and toweling, such as the continuous cabinet crash shown here are standard for industrial use, just as Martex bath towels are standard in the finest homes and hotels.

* Recent testimony before a government department at Washington, D. C., by a representative of a nation-wide research organization, showed the average person uses 2.45 paper towels for each drying.

WELLINGTON SEARS CO.

65 WORTH STREET
NEW YORK CITY

BOSTON PHILADELPHIA ATLANTA DETROIT CHICAGO ST. LOUIS NEW ORLEANS SAN FRANCISCO

THE METALLURGIST

USES A GOOD SPECTOGRAPH BECAUSE HE CAN DEPEND UPON IT!

FOR THE SAME REASON, THE INDUSTRIAL USER SPECIFIES

Osborn Brushes

Advancement of industrial science is made possible by the dependable performance of laboratory instruments. As a matter of fact... all industrial activities are improved through the use of products accurately made for their respective job requirements. Osborn believes industrial brushes are no exception. That is why Osborn Brushes are made to high standards of quality and craftsmanship... so every Osborn Brush will deliver the maximum of dependable performance. Osborn and Osborn Industrial Distributors are organized to serve the brush needs of Industry... adequately and economically.

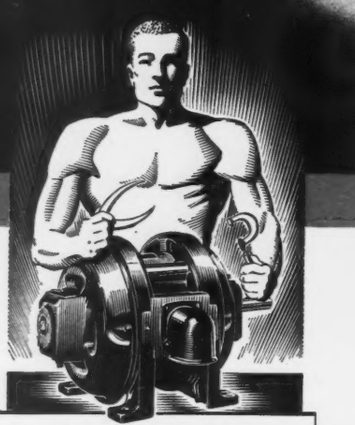
OSBORN THE OSBORN MANUFACTURING COMPANY

5401 Hamilton Avenue • Cleveland, Ohio

Sales Offices: New York • Detroit • Chicago • San Francisco

FOR DEPENDABLE, LONG-LASTING, LOW-COST SERVICE

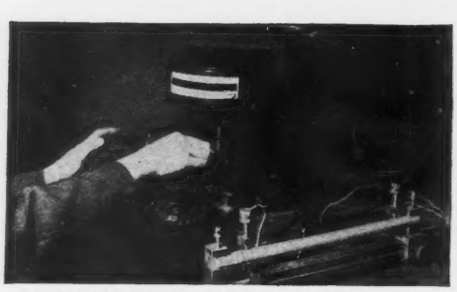
BOTH SAMPLES ARE



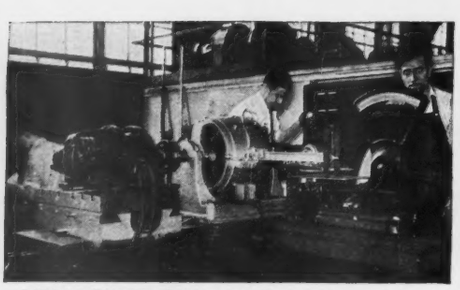
G-E MOTORS PASS ALL TESTS

CARBON TEST—Steel and cast iron are tested for carbon content to make sure that they meet the high G-E physical-property standards

STRENGTH TEST—Shaft and frame materials are regularly tested to destruction to make certain that they meet the rigid G-E standards



CONDUCTIVITY TEST—Aluminum is tested for conductivity before it goes into the indestructible rotors of G-E motors. This is to assure economical operation

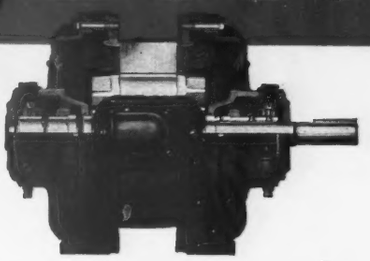


DYNAMOMETER TEST—Speed-torque characteristics of General Electric induction motors are determined accurately by dynamometers like this

ACCURACY TEST—Skilled workmen, using precision instruments, inspect the motor parts to make certain that they meet the exacting G-E specifications

GENERAL ELECTRIC

SILICON STEEL, BUT...



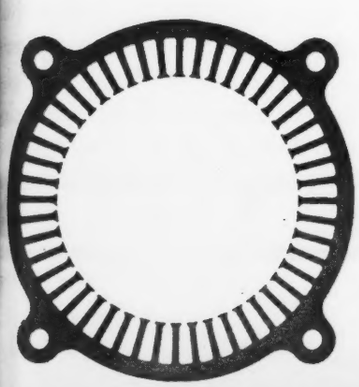
NO matter how closely you examine these samples of silicon steel—or how accurately you determine their chemical analysis—you can't tell them apart. Yet one of them has high permeability; the other, low permeability.

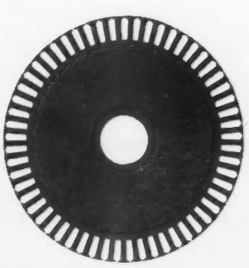
If the rotor and stator laminations of G-E induction motors were made from silicon steel of low permeability, relatively high core loss would result and the motors would not operate so economically and dependably.

To make absolutely sure that only nonaging silicon steel of high permeability goes into General Electric motors, samples from each shipment are given the Epstein test. Only if the samples pass this test will the steel go into G-E motors.

This and other tests of materials before the motors are made, and tests during their construction and after they are completed, are your assurance that when you buy a G-E motor, you are getting one which will give the utmost in long life and low operating costs. Buy motors that pass *all* tests—they pay you bigger dividends.

Mail the coupon for complete information on the new G-E splashproof motor—new insulation, new end shields, new conduit boxes, and many other new features which mean longer motor life.



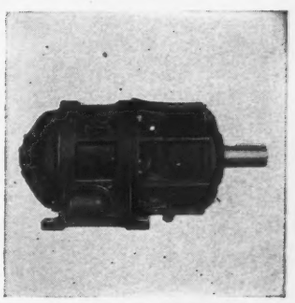


These stator (left) and rotor (right) laminations for G-E induction motors are made from non-aging silicon steel which conforms to the high G-E standards for permeability and low core loss

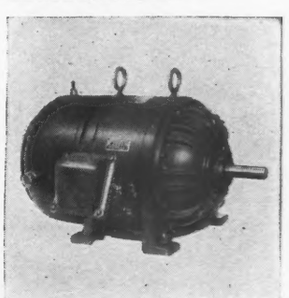
EPSTEIN TEST—Even though the silicon steel used by General Electric is made under the direct supervision of a staff of trained G-E metallurgists, it is given this Epstein test to make sure that it meets the high G-E standards of permeability

HOW THESE MOTORS WILL SAVE YOU MONEY

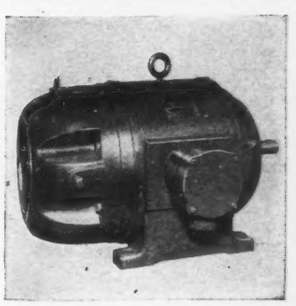
On jobs where there are splashing liquids or falling particles, the G-E splashproof motor will give you longer motor life and lower operating costs



Where you need a compact, efficient, low-speed power unit, use a G-E gear-motor—it will help you reduce power-equipment investment and power costs

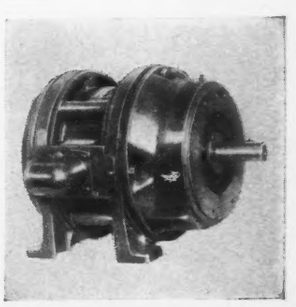


G-E totally enclosed, fan-cooled motors will quickly pay for themselves in lower upkeep costs on dusty, dirty jobs. Write for our new bulletin, GEA-1326B



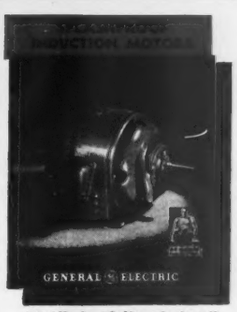
Protect your men and equipment by using G-E explosion-proof motors in Class I, Group D, hazardous gas locations.

Use G-E vertical motors on pumps, machine tools, agitators, etc. They save space and eliminate gearing. All types are available



G-E face- and flange-type motors reduce cost for machinery manufacturers by saving development expense and simplifying machine design

FREE—NEW BULLETIN ON SPLASHPROOF MOTORS



It's filled with "inside facts" about G-E splashproof induction motors

General Electric
Dept. 6G-201
Schenectady, N. Y.

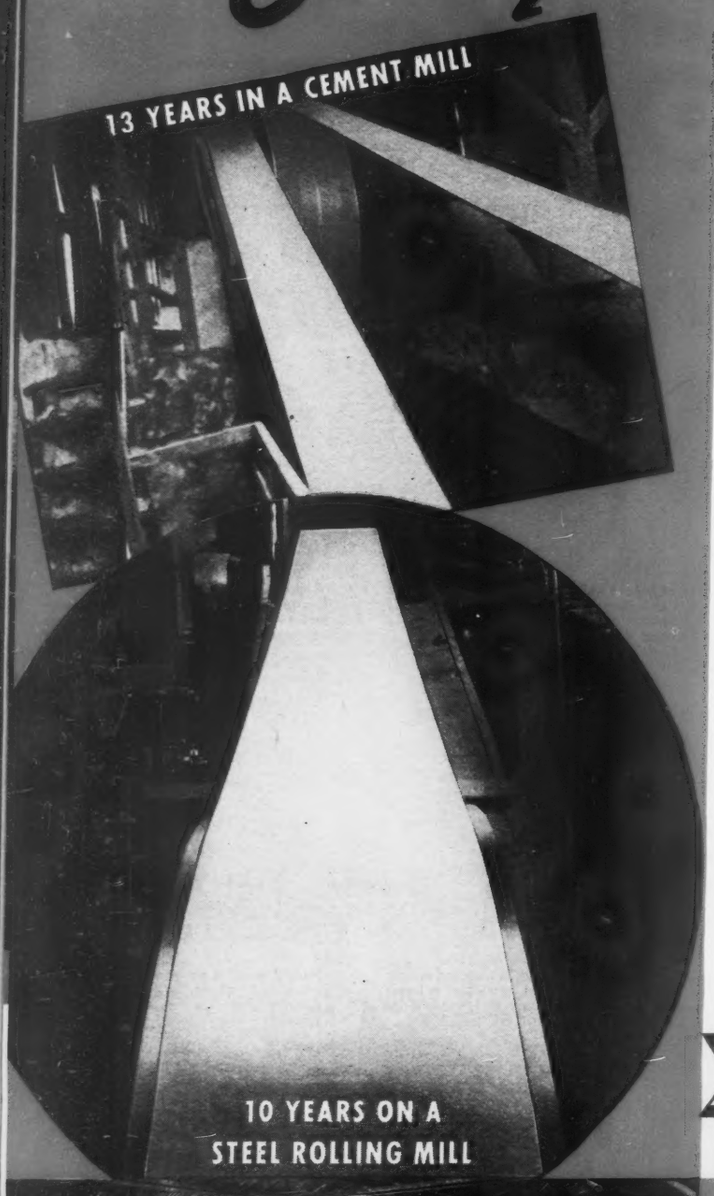
Please send me a copy of this bulletin (GEA-1619B) on your new splashproof motors.

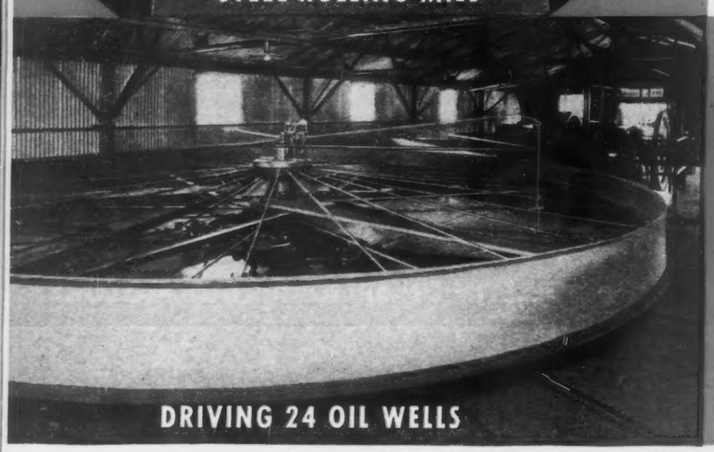
Name.....

Company.....

Address.....020-269

FIT *Every* BELT JOB WITH A





Made to Order

LARGE and small—odd sizes, and those easy to fit—U. S. Rubber "tailors" a belt for every type of drive.

Looking around oil fields, mills, and factories, you'll see U. S. Transmission Belts doing big and little jobs *well.* For instance... operating under severe dust conditions in a cement plant a U. S. Rainbow Transmission Belt has given perfect service for 13 years . . . this same Rainbow brand that for 40 years has been meeting requirements of every conceivable type of drive . . . unmatched for sustained performance. In a steel rolling mill 30″ 8-ply U. S. Giant Stitched Rubber Covered Transmission Belt gave 10 years' continuous service, *and was then replaced three years ago with a new U. S. Giant.* On an oil field power drive in Texas a U. S. Royal Cord Cut Edge Endless Belt 187′ 24″, 9-ply, pumps 24 wells. A cotton oil mill is replacing leather belts with 10″, 5-ply Royal Belting, which due to its unusual strength and stamina gives unusual service although practically running in a pile of cotton seed. On light machine drives there is no equal to U. S. Royal Jr. . . . a light, flexible, and elastic belt which permits the use of thick belts for the narrow widths customary to such transmission service, especially when frequent shifting is required.

Get in touch with your nearest U. S. Rubber representative. You may save *dollars* in initial cost—operating cost—replacement cost. Let him *fit your job* with the *right U. S. Transmission Belt.* Write for "An Album of Familiar Belts," containing many interesting transmission application photographs.

United States R

United States Rubber Products, Inc.

1790 Bro

HA U.S. TAILORED BELT!

Fitted to Their Loads

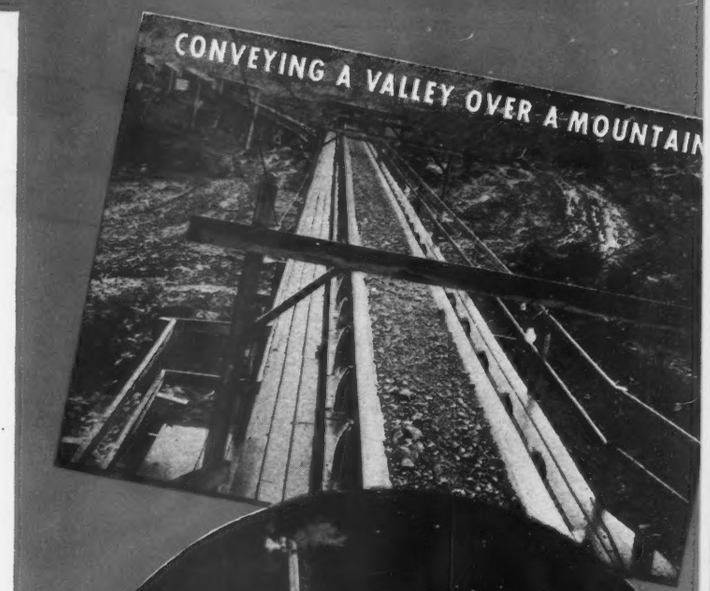
U.S. Conveyor Belts are also tailored to carry their loads fittingly. Go down into a mine . . . or a big excavating job . . . or walk through most any great plant . . . you'll find them hard at work.

On the Grand Coulee Dam you will see 60" U. S. Matchless Conveyor Belts which have already carried *11,000,000 cubic feet of excavation* from dam site to dump nearly *a mile away,* and almost *400 feet above the river.* On a Pennsylvania hilltop a U. S. Giant Conveyor Belt 1800 feet long lowers run-of-mine coal from the mouth of the mine to tipple. Many other U. S. Conveyor Belts underground in this mine take coal from mine face to surface. In a large limestone plant U. S. Matchless Conveyor Belts especially tailored of 42-ounce duck for exceptional strength to lift 2800 tons an hour, 147 feet, using 500 horsepower. A "whopper" of a belt! 1355 feet of 60", 10-ply U. S. Matchless Conveyor Belt especially "fitted" to do a bigger job for a western mining company. This roll of belt is 11 feet high; weight 15 tons; made under ideal conditions in the huge, well-equipped belt room of U. S. Rubber, Passaic, N. J. Specifications were checked and double checked to insure a "perfect fit" without a repair or blemish. Now in service, it's carrying approximately 20,000 tons of copper ore a day.

These are typical of many installations where U. S. Conveyor Belts are effecting large savings in conveying costs — and carrying their loads efficiently over long periods of time. Use them on *your* job. We will gladly send you, on request, the U. S. Conveyor Belt Album of installation photographs.

s Rubber Company

1790 Broadway, New York, N. Y.



UNITED STATES RUBBER COMPANY
MATCHLESS CONVEYOR
32-OZ. P-61

UNITED STATES RUBBER COMPANY
AMAZON CONVEYOR
32-OZ. P-44

UNITED STATES RUBBER COMPANY
GIANT CONVEYOR
32-OZ. P-44

UNITED STATES RUBBER COMPANY
SECURITY CONVEYOR
28-OZ. P-44

It will Pay You to Use G-E WIRING MATERIALS

From the point where electrical power begins its distribution in your plant, it will pay you to use G-E Wiring Materials.

You have production schedules to maintain and customer orders to fill, therefore, you cannot gamble with production delays and lost orders by relying on ordinary wiring materials to conduct power to your machines.

G-E Wiring Materials are of sturdy construction and the highest quality. With them, you can be sure of continuous and efficient transmission of power in your plant. For economical and dependable service, install G-E White Rigid Conduit, G-E Boxes and Fittings — G-E "Safecote" Building Wire, All-rubber Cords — G-E Fiberduct Underfloor Wiring Systems — and G-E Wiring Devices, such as switches, convenience outlets, plates, fuses and plugs.

See your nearest G-E Merchandise Distributor or write Section CDW-8611, Appliance and Merchandise Dept., General Electric Company, Bridgeport, Connecticut.

GENERAL ELECTRIC

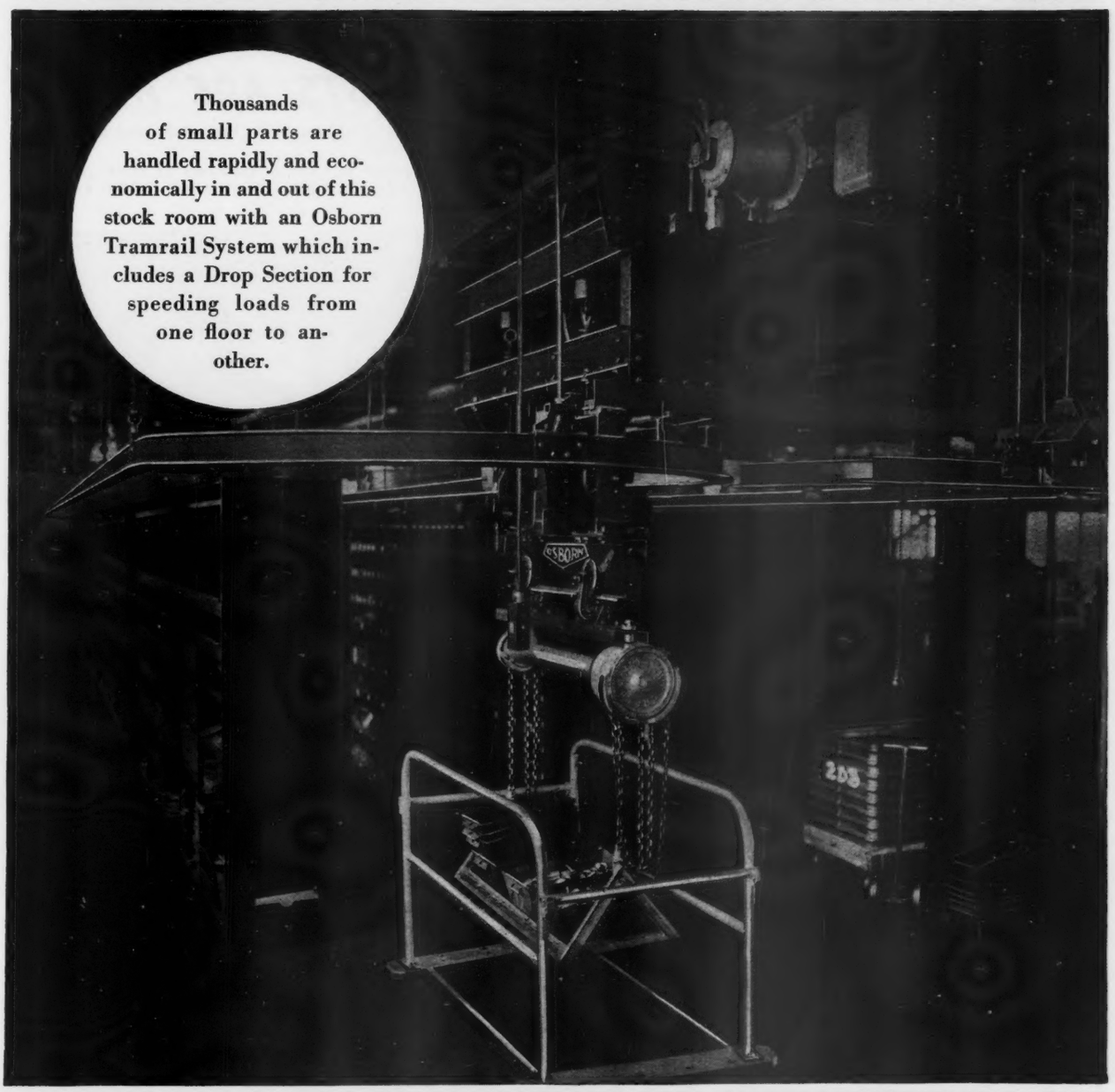
WIRING MATERIALS

APPLIANCE AND MERCHANDISE DEPARTMENT, GENERAL ELECTRIC COMPANY, BRIDGEPORT, CONN.

OSBORN

TRAMRAIL SYSTEMS

SHORTEST ROUTE TO ECONOMICAL MATERIALS HANDLING



Thousands of small parts are handled rapidly and economically in and out of this stock room with an Osborn Tramrail System which includes a Drop Section for speeding loads from one floor to another.

ABOVE THE HOOK

"ABOVE THE HOOK" PROBLEMS ARE SOLVED BY THE CORRECT COMBINATION OF OSBORN TRAMRAIL UNITS

"BELOW THE HOOK" PROBLEMS ARE SOLVED BY THE CORRECT OSBORN-DESIGNED GRAB EQUIPMENT

BELOW THE HOOK

THE OSBORN MANUFACTURING COMPANY · 5401 HAMILTON AVE · CLEVELAND, OHIO · U.S.A.

"HORSE and BUGGY" FLOORS for "4 LANE HIGHWAY" PLANT TRAFFIC?

NO WONDER FLOOR COSTS ARE HIGH!

WHEN the horse and buggy set the pace of transportation, floors presented no great problem. Early "improved" road surfaces, too, were adequate till the occasional clatter of hoofs became a continual roar of motors.

Modern plant traffic lanes, like modern highways, carry a service load once undreamed of. And in thousands of plants, where conventional flooring materials are breaking under the strain, floor maintenance costs go sky-high. The answer? Central Rolled Steel Floor Plate.

CENTRAL *Rolled Steel* FLOOR PLATES

. . . BUILT FOR THE TRAFFIC LANES OF MODERN *FAST MOVING* INDUSTRY

RUGGED. Tough, long-lived steel plates that easily stand the pounding, abrasion and abuse of busy industrial truck traffic . . . . . the handling of heavy parts . . . . . the passage of men and materials shift in and shift out.

SAFE. The ideal combination tread design for sure-footed safety, wet or dry. These service-proved patterns meet all plant requirements, provide for both foot and truck traffic the surface best suited to speed, durability and safety. Remember, too, that these advantages of Central Floor Plate are permanent advantages unaffected by long years of service.

FAST. Covered tread design, easy to walk on, smooth and fast-running under trucks or skids. Floors that make work and materials handling easier and faster. Modern floors for modern high-speed industry.

CLEAN. No places for dirt and dust to hide. No porosity to absorb oil, grease or chemical substances. Central Floor Plate is always a credit to plant and department, as clean and efficient after years of hard service as the day it was installed. Clearly, the ONLY flooring for some purposes and by far the most economical for heavy traffic points in all plants. We have a complete little booklet which tells this story in full detail . . . . . shows forms, sizes and necessary installation data for Central Rolled Steel Floor Plates, Step Treads, Machine Platforms, etc. Write for it — — — it's free.

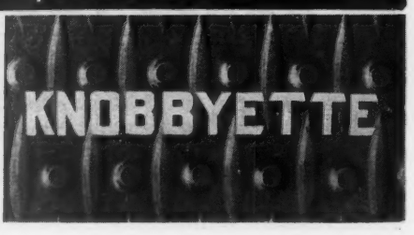
ALL-WAY GRIP—The general purpose flooring. Maximum non-skid qualities. Easy to walk on. Easy to truck on.

KNOBBY—Greatest possible grip efficiency through perfect foot support. Recommended for heaviest traffic loads.

KNOBBYETTE—All the good qualities of KNOBBY design in a lighter duty flooring for general plant use. Clean, handsome, durable.

THREE TYPES • • • Each designed to meet a specific need • • •

CENTRAL IRON and STEEL COMPANY
Harrisburg, Pa.



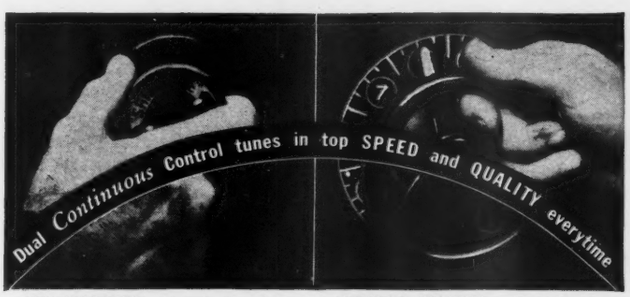
Now-the right TYPE and SIZE of ARC for every JOB...

NOW, the heat of the welding arc can be varied as to *type* as well as to *intensity*... tuned for every job to give maximum speed and quality everytime.

The new "*Shield-Arc SAE*" Welder with its Dual *Continuous* Control makes possible this new-found accuracy and convenience.

With a twist of the wrist, the welder can "set" the Job Selector and Current Control of this new machine to get the *ideal* arc for each and every requirement. He can get an arc for high-speed deposit on beveled plates... a deeply penetrating arc for heavy butt joints... a short, forceful arc for overhead work... a flexible arc for work in the wind—in fact, any kind of arc *independent* of the welding current.

Acquaint yourself with this Lincoln development that puts welding years ahead. The coupon will bring you a book giving full details. THE LINCOLN ELECTRIC COMPANY, Dept. R -317, Cleveland, Ohio. Largest Manufacturers of Arc Welding Equipment in the World.



JOB SELECTOR—*A continuous adjustment which gives any type of arc to suit the job.*

CURRENT CONTROL—*A continuous adjustment which varies the arc intensity to suit the job.*

FREE—
A book-full of NEWS
Mail the Coupon TODAY

"SHIELD-ARC SAE"
—the New Lincoln Welder with DUAL Continuous CONTROL and Self-Protecting Motor

THE LINCOLN ELECTRIC CO.
Dept. R -317, Cleveland, Ohio

Please send a copy of the new publication, "The New Arc Welding Technique," to—

Name _____

Position _____

Company _____

Address _____

City _____ State _____

"ASLEEP IN THE DEEP"

Goodrich Creates Newest Improvement in Mattresses

MATTRESS manufacturers faced a tough problem for years. They wanted to make their better grades without humps or tufts—but there was no satisfactory material for bridging the gaps between springs. Pads of inelastic material finally lost their shape, allowed the cotton to shift about, resulted in discomfort.

Goodrich Application Engineers developed a method of weaving hair into loops, and dipping them in latex—first form of rubber. The result—called Nukraft—is upholstery with no tufts nor bumps but, instead, *permanent comfort.*

Makers of mattresses, furniture, automobiles, theatre seats seized upon this new Goodrich invention. Their sales leaped — because people will always pay for comfort.

Whether you make mattresses or motor boats, arm chairs or airplanes, the story of Nukraft is important to you. It illustrates the ability and aggressiveness of Goodrich engineers in improving and developing new products which revolutionize old and even stabilized industries.

Goodrich engineers have developed new rubber compounds, and new products made from them—with fresh sales appeals, lower costs, improved quality. If you would welcome these features in your business, your products, write The B. F. Goodrich Co., Mechanical Rubber Goods Division, Akron, Ohio.

Goodrich

ALL *products problems* IN RUBBER

KNOW THE MEANING OF THE RLM LABEL

On Industrial Lighting Reflectors

BETTER Light, More Light with Lower Operating and Maintenance Costs . . . these are the four fold advantages delivered by reflectors bearing the RLM Label. Remember this mark of highest quality when purchasing or specifying industrial lighting equipment.

Members of
RLM STANDARDS INSTITUTE
Incorporated

RLM Standards Institute, is a non-profit organization, dedicated to the establishment and maintenance of quality standards in industrial lighting equipment.

ABOLITE REFLECTOR COMPANY
West Lafayette, Ohio

BENJAMIN ELECTRIC MFG. CO.
Des Plaines, Illinois

GOODRICH ELECTRIC COMPANY
Chicago, Illinois

THE MILLER COMPANY
Meriden, Connecticut

OVERBAGH AND AYRES MFG. CO.
Chicago, Illinois

QUADRANGLE MFG. COMPANY
Chicago, Illinois

WESTINGHOUSE ELECTRIC AND MFG. COMPANY
Cleveland, Ohio

WHEELER REFLECTOR COMPANY
Boston, Massachusetts

1 MORE LIGHT AT NO EXTRA COST

Efficiency specifications for RLM reflectors are from 10-12% higher than average reflector efficiency. Yet RLM reflectors cost so little more that the higher light output month after month and year after year saves . . . many times over . . . the slight additional first cost.

2 PORCELAIN ENAMEL REFLECTING SURFACE

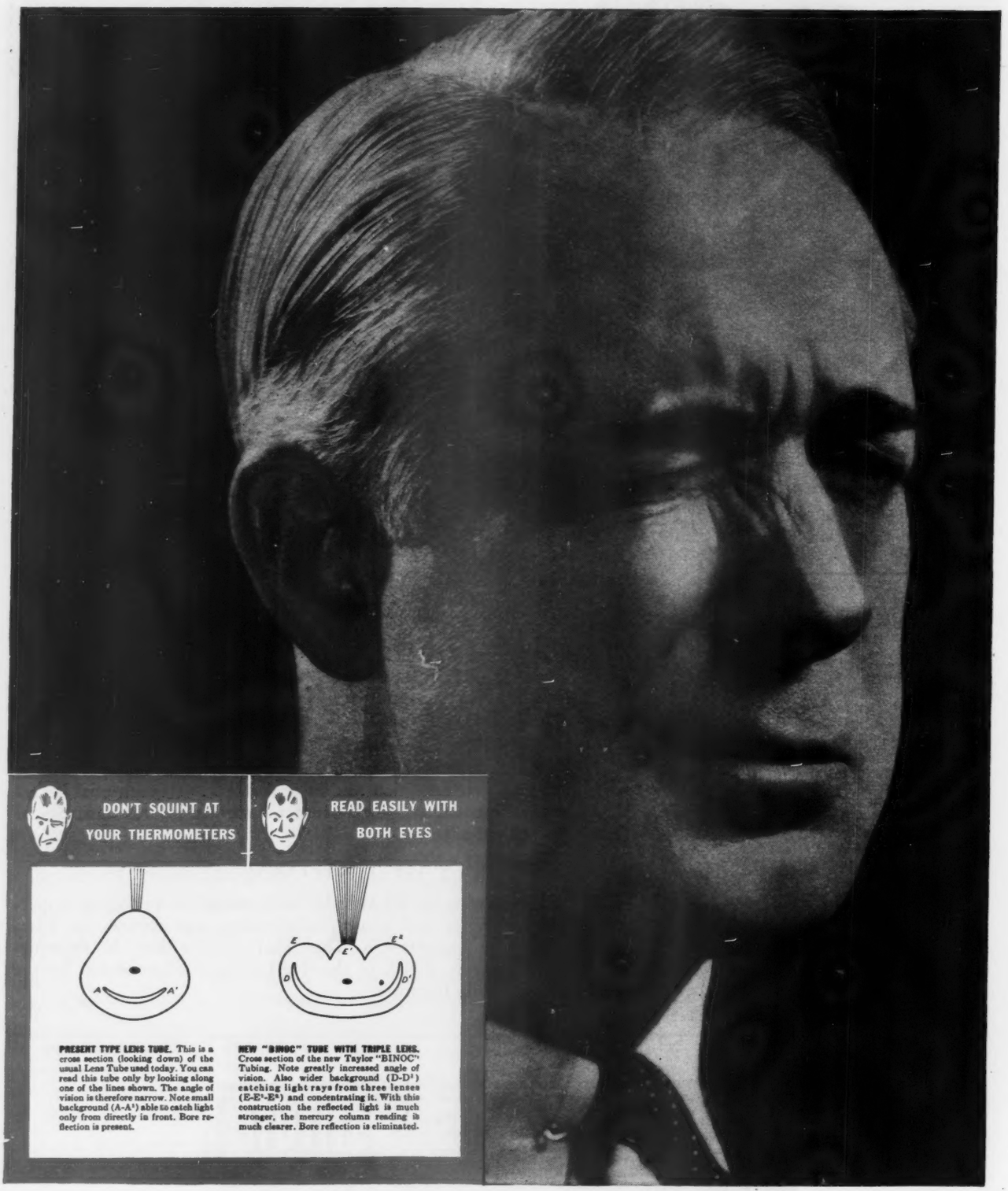
RLM standard specifications insist on the highest grade of porcelain enameled steel, for economy and efficiency. Durable . . . impervious to any atmospheric condition . . . unbreakable . . . this material lowers maintenance costs. Its perfect reflector surface insures unsurpassed all-round light efficiency.

3 WARRANTY OF UNIFORM QUALITY

Reflectors bearing the RLM Label have passed the periodical inspections made by the well known, independent organization, the Electrical Testing Laboratories. This label certifies that the reflectors conform, in every detail, to the RLM standards established by the RLM Standards Institute.

RLM STANDARDS INSTITUTE
INCORPORATED

DON'T



DON'T SQUINT AT YOUR THERMOMETERS

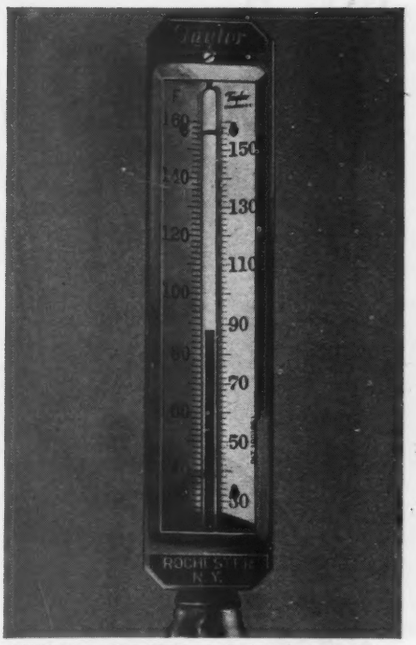
READ EASILY WITH BOTH EYES

PRESENT TYPE LENS TUBE. This is a cross section (looking down) of the usual Lens Tube used today. You can read this tube only by looking along one of the lines shown. The angle of vision is therefore narrow. Note small background (A-A^1) able to catch light only from directly in front. Bore reflection is present.

NEW "BINOC" TUBE WITH TRIPLE LENS. Cross section of the new Taylor "BINOC" Tubing. Note greatly increased angle of vision. Also wider background (D-D^1) catching light rays from three lenses (E-E^1-E^2) and concentrating it. With this construction the reflected light is much stronger, the mercury column reading is much clearer. Bore reflection is eliminated.

SQUINT at your thermometers

Read them now with both eyes open more easily, more accurately, at greater distances with—**NEW TAYLOR "BINOC" TUBING**



THIS IS A PICTURE *of the latest Taylor Industrial Thermometer with the new Taylor* "BINOC" *Tubing. Do not attempt to judge anything from this picture except the modern, clean-cut design and appearance of this new instrument. Test the actual instrument yourself and prove its superiority.*

"REMARKABLE!" "Wonderful!" "A really big development!" "The greatest advance of its type in thermometer history."

Unusual praise indeed. But it is praise of an unusual product.

With "Binoc" Tubing, Taylor makes previous industrial thermometers obsolete.

"Binoc" Tubing ends squinting with one eye. It does away with "approximately accurate" readings. It gives thermometers that can be read *with both eyes open*. It gives *Binocular Vision.*

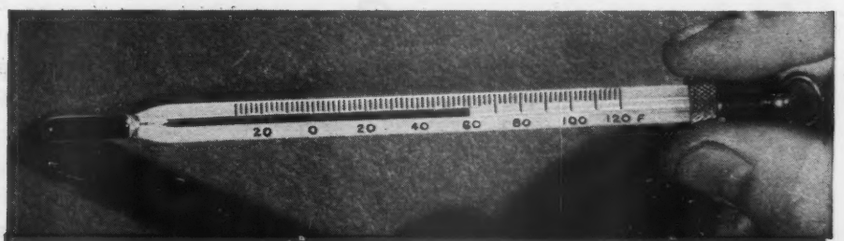
It supplies a thermometer with double the angle of vision—with two to five times the visibility of previous thermometers. And does it without sacrificing high magnification.

It eliminates bore reflection, which has been one of the greatest handicaps in making accurate readings on any thermometer up to now.

All of these amazing advantages result from correct application of the principles of light reflection. A triple lens construction assures the wider angle of vision, greater concentration of light, and the necessary light reflection on the mercury column. *In other words, it gives a thermometer that is many times easier to read.*

Prove that Taylor Industrial Thermometers equipped with this new tubing are the most efficient and easy to read available today. A Taylor Representative will present the complete story, and let you make a test with your own eyes so that you can be the judge. Or you can get full information from your jobber. If you want a demonstration quickly, write at once to Taylor Instrument Companies, Rochester, N. Y. or Toronto, Canada.

Taylor
INDUSTRIAL THERMOMETERS
with **"BINOC"** *tubing*
REG. U. S. PAT. OFF.



BUY THIS NEW TAYLOR POCKET TEST THERMOMETER WITH "BINOC" TUBING...

Prove the remarkable advantages of "BINOC" Tubing right away in a thermometer of your own. Use the coupon and get one of the always useful Engineer's Pocket Test Thermometers (Range—50° to 120° F.) just produced by Taylor with the new tubing. There are a thousand and one uses for it. And you can know just what easy reading really means. Fill out the coupon, attach your check or money order, and mail today for your own thermometer.

TAYLOR INSTRUMENT COMPANIES,
Dept. C 4, Industrial Sales, Rochester, N. Y.

I want to see "BINOC" Tubing. I enclose check for the Engineer's Pocket Test Thermometers (with protective case).

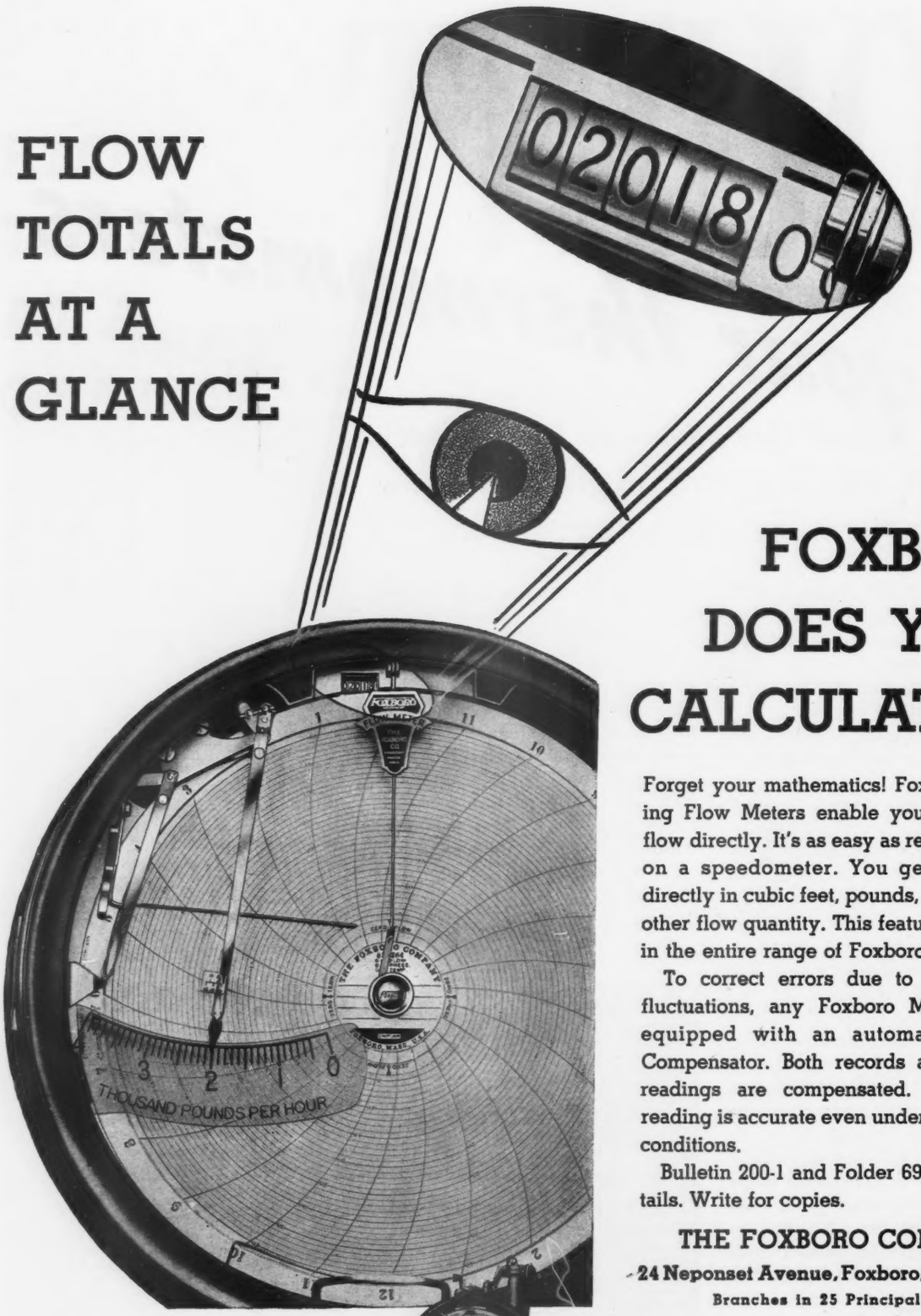
CHECK HERE WITH RANGE —30° to 120° F—$1.25 EACH ☐
WITH RANGE 0° to 220° F—$1.50 EACH ☐

NAME_____

COMPANY AND TITLE_____

CITY_____ STATE_____

FLOW TOTALS AT A GLANCE



FOXBORO DOES YOUR CALCULATING

Forget your mathematics! Foxboro Integrating Flow Meters enable you to read total flow directly. It's as easy as reading mileage on a speedometer. You get the answer directly in cubic feet, pounds, gallons or any other flow quantity. This feature is available in the entire range of Foxboro Flow Meters.

To correct errors due to line pressure fluctuations, any Foxboro Meter may be equipped with an automatic Pressure Compensator. Both records and integrator readings are compensated. The Foxboro reading is accurate even under most adverse conditions.

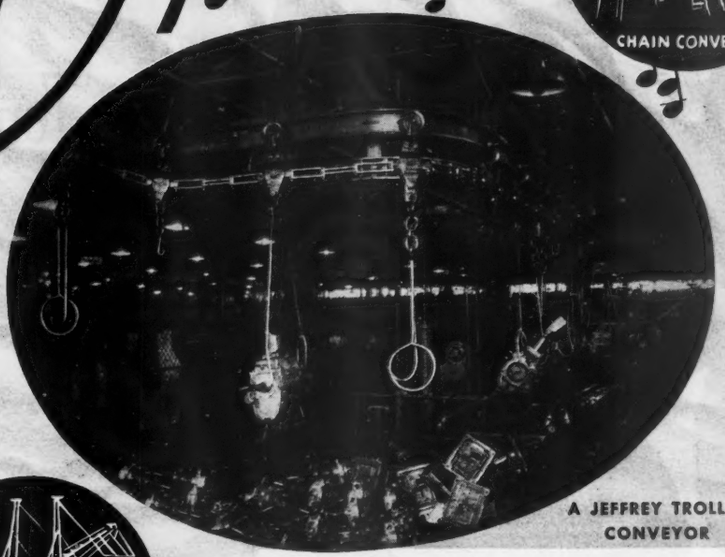
Bulletin 200-1 and Folder 692 give full details. Write for copies.

THE FOXBORO COMPANY
24 Neponset Avenue, Foxboro, Mass., U.S.A.
Branches in 25 Principal Cities

FOXBORO FLOW METERS

ACCURACY FOXBORO *RESPONSE*

"Bravura"



A JEFFREY TROLLEY CONVEYOR

"BRAVURA", says our handy guide to opera, "is a showy passage that requires dash, spirit and brilliant execution". In other words, the tenor is allowed to "stomp" his feet and yell louder than anybody else on the stage.

The man who is obliged to face modern competition with obsolete material handling methods is entitled to something like that . . . a long loud yell over the impossibility of keeping costs down. The more "dash" and "spirit" he puts into the "execution" of this yell, the sooner he will obtain the cost-saving equipment he needs.

Yells of this sort are conspicuously missing from the plants equipped with Jeffrey Modern Conveying and Reduction systems. The predominant sound to be heard is the cheerful, steady hum of machines turning out goods to make a profit from rising demands for products of all kinds.

Because the long experience . . . the up-to-the-minute engineering which Jeffrey brings to every conveyor job . . . inevitably get results in cost reduction and more satisfactory operation.

Jeffrey offers every type and size of conveyor . . . and Jeffrey Engineers certainly know how to apply them to win applause.

JEFFREY—CONSULTANT— A thorough check-up of your conveying systems by an expert is advisable from time to time . . . to be certain you are getting all possible cost saving. We will be glad to furnish the expert . . . without obligation.

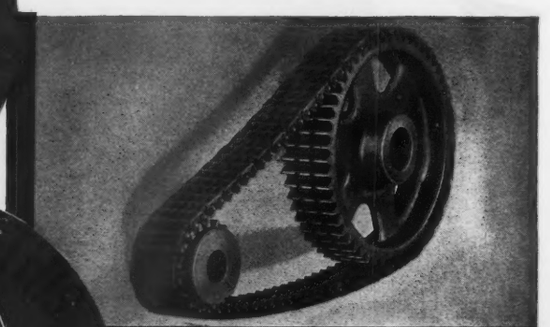
THE JEFFREY MANUFACTURING COMPANY

911-99 North Fourth Street, Columbus, Ohio

JEFFREY

MATERIAL HANDLING EQUIPMENT

Put some T.N.T.* (Teeth Not Tension)



*Teeth, Not Tension turn MORSE CHAIN DRIVES

Think how you bear down to get a grip on a smooth-faced pulley wheel. It's nearly as difficult to grip a grooved wheel. But you can grip a toothed wheel.

That's the secret of Morse T.N.T. (Teeth, Not Tension) Silent Chain Drives. The chain on a toothed pinion and sprocket always has a sure-fire, positive grip. It simply cannot slip.

The answer is that Morse Chain Drives cut your power costs because—

THE EASIER IT IS TO TURN
THE CHEAPER IT IS TO TURN

STOP N.P.L. (NEEDLESS POWER LOSS)

N. P. L. (Needless Power Loss) robs manufacturers of millions of dollars a year. It needn't rob you of one cent. MORSE Positive Drives are 98.6% efficient. They can, and will, wipe out practically *all* of your present power losses.

MORSE

MORSE CHAIN

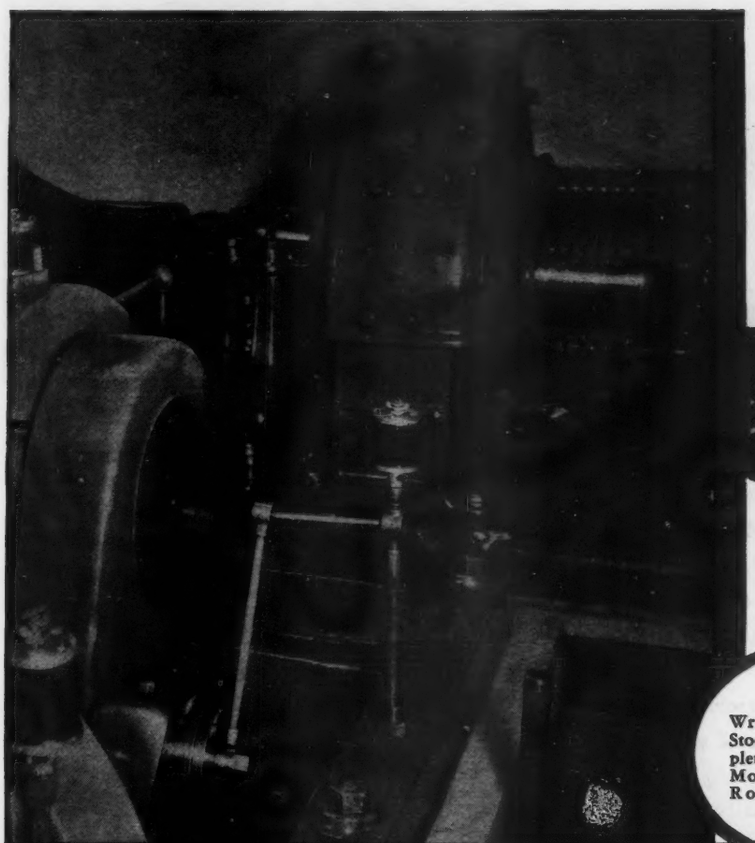
under your power-transmission lo$$e$

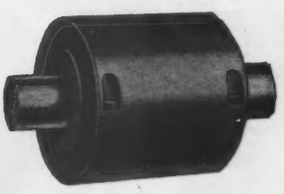
Of course, you don't keep special ledgers and red ink to record your power losses. But day after day, the power drained from your motors by horse-and-buggy transmissions costs you many a good, round, hard dollar. This loss shows up in your regular books—somewhere. . . .

One recent Morse Silent Chain convert writes: "With the old belt drives we turned out 2400 threads (on pipe nipples) a day. Now we turn out 5000 a day. The belts slipped, but the Morse chains grip every tooth with a vengeance." Think how many round dollars his old power drives must have cost him! And this is a typical letter.

Teeth, Not Tension—give Morse Silent Chains their grip. They can't slip. They don't drain power, for there's no slippage of tension to take its toll. Tests prove Morse Silent Chain Drives are 98.6% efficient. The Morse version of T.N.T. is helping thousands of manufacturers step up their schedules, squeeze more power out of their motors, and sign the death warrant to costly transmission breakdowns.

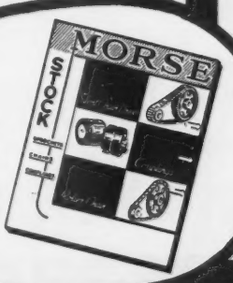
Use T.N.T. on all your power drives and watch your maintenance costs slide down and your useful power output climb up. Call your local Morse representative or write to our engineering staff here in Ithaca.





MORSE FLEXIBLE COUPLINGS are of two types—STANDARD—consisting of two facing sprockets wrapped in a silent chain; and MORFLEX using Rubber as the flexing medium

MORSE ROLLER CHAINS *take in* and *hold* 70% more oil than any other type of roller chain you can buy. Users write us that Morse Roller chains outwear and out-perform all others

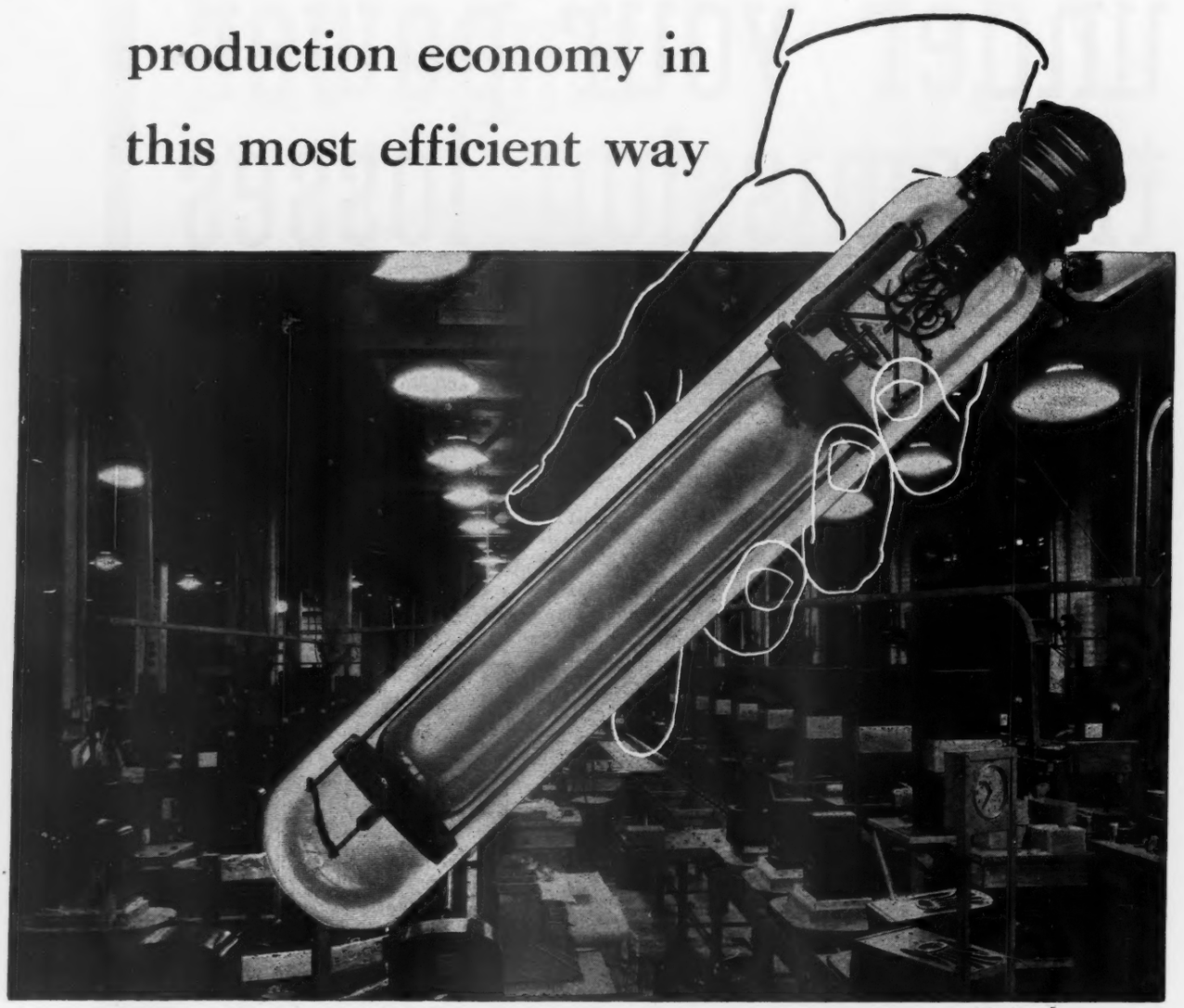


Write for new Morse Stock Book giving complete information about Morse Silent Chains, Roller Chains and Couplings

positive CHAIN DRIVES

COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

Throw more light on production economy in this most efficient way



A typical installation of General Electric Mercury Lamps in a well-known plant.

Throughout industry higher levels of illumination are being obtained, at a lower cost per foot-candle, by means of General Electric Mercury Lamps. These modern, efficient sources of light are promoting more economical, more efficient production everywhere. With the higher levels of illumination, rejects are minimized . . . there is no waste of energy in the mere physical act of "seeing" . . . and eye-strain is reduced materially. As a result, end-of-shift fatigue is banished and workmen can produce a more uniform, accurately finished product at lower cost.

General Electric Mercury Lamps are available in two sizes—400 watts and 250 watts. Both are adapted for use on 115- or 230-volt lines, and both have a rated life of 2,000 hours. These lamps have an efficiency 50 to 100% higher than that of other light sources.

For complete details address . . .

Order your auxiliary devices which were designed especially for this lamp from the General Electric Vapor Lamp Company.

GENERAL ELECTRIC

751H

General Electric Vapor Lamp Co.
815 Adams Street, Hoboken, N. J.

Incandescent Lamp Department
Nela Park, Cleveland, Ohio

Save *Time* and *Money* through J&L Warehouse Service

Quick *Dependable* Service on J&L Steel Products...

When you need steel quickly, for either emergency or regular requirements, you will save time, money and trouble by ordering from your J & L Warehouse.

J & L Warehouse service is fast and complete. Warehouses are strategically located to give you prompt service. Shipments are generally made immediately upon receipt of your order; always within 24 hours.

Warehouse stocks are diversified, complete and carefully classified as to qualities, and trained steel men know exactly what grade will best meet your need.

Special saws, lathes, shears, punches, flame-cutting and fabricating equipment in J & L Warehouses give you steel for your construction, maintenance and repair requirements in ready-for-use form. This saves time and money and helps you avoid costly delays in operation.

Steel users everywhere depend on J & L Warehouses for time-and money-saving quick service. You, too, will profit when you order from your J & L Warehouse. Write for the J & L Warehouse combined stock list. No obligation.

JONES & LAUGHLIN STEEL CORPORATION
AMERICAN IRON AND STEEL WORKS
PITTSBURGH, PENNSYLVANIA

AND BE SURE . . .

J&L WAREHOUSES

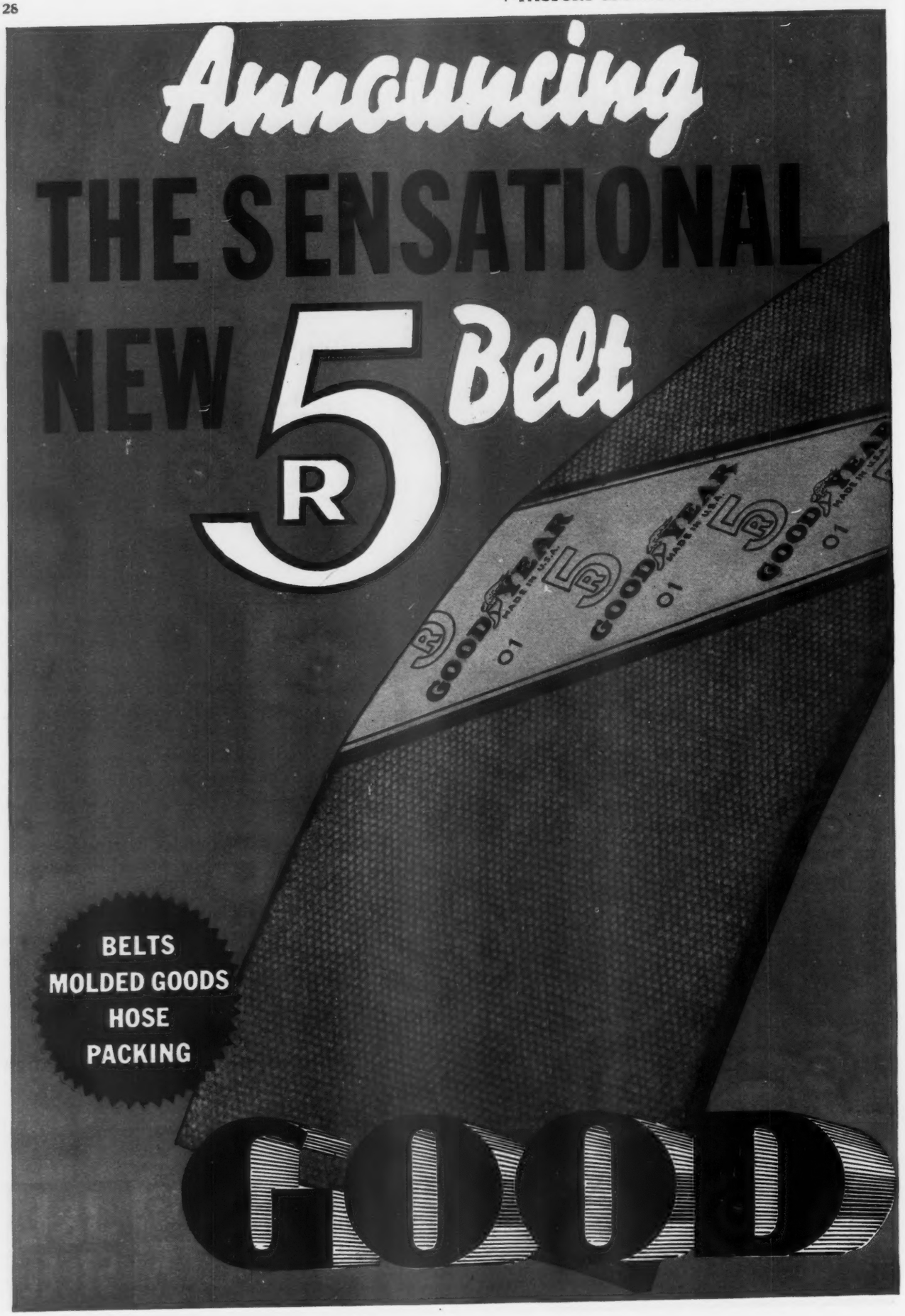
CHICAGO Virginia 1600 · CINCINNATI Main 2324 · DETROIT Plaza 0470 · NEW ORLEANS Franklin 1131 · PITTSBURGH Hemlock 1000

NEW YORK (Long Island City)—Ironsides 6-8700 . . . Operated by National Bridge Works Division of Jones & Laughlin Steel Service, Inc.

LOUISVILLE—Magnolia 2140 . . . Stock of Bars for Concrete Reinforcement and Bar Fabricating Yard

MEMPHIS—6-4836 . . . Distributing Warehouse for Pipe, Sheets, Spikes and Wire Products. Reinforcing Bar Warehouse and Fabricating Shop

J&L STEEL


Announcing
THE SENSATIONAL
NEW 5R Belt
GOODYEAR
MADE IN U.S.A.
01
BELTS
MOLDED GOODS
HOSE
PACKING
GOOD

WHY IT IS CALLED THE 5R
100 LBS. effective tension
SLACK SIDE TENSION
Ordinary Belt — 100 lbs.
Goodyear 5-R Belt — 25 lbs.
TIGHT SIDE TENSION
Ordinary Belt — 200 lbs.
Goodyear 5-R Belt — 125 lbs.

The "R" of a belt is the ratio between tensions on the tight or "pulling" side and slack or "returning" side necessary to maintain the effective tension required to operate the drive—and depends upon the coefficient of friction between belt and pulley. For example, an ordinary belt with an "R" of 2 must be operated at 200 lbs. tight side tension and 100 lbs. slack side, or a total of 300 lbs., to deliver 100 lbs. effective tension. The new Goodyear 5-R Belt is so named because its higher coefficient of friction gives it a minimum "R" of 5. To maintain an effective tension of 100 lbs., it requires a tight side tension of only 125 lbs. and 25 lbs. slack side, or 150 lbs. total—reducing bearing pressure and insuring longer belt-life.

Pulls heaviest loads at 25% to 50% lower tension without slip!

AFTER years of research Goodyear engineers present a revolutionary development in flat transmission belting—a square-edge fabric belt with a *permanent minimum ratio of tension*, or "R," of 5. Hence its name—the Goodyear 5-R.

What that means in terms of belt efficiency non-engineers will find explained in the adjoining diagram. Briefly, it handles any given load at 25% to 50% lower tension without slip and far less stretch!

Highest coefficient of friction

The secret of the 5-R's amazing slack-tension operation is a new Goodyear-perfected non-rosinous rubber compound impregnated through the fabric which gives it a coefficient of friction—a pulley grip—*unexcelled in any other type of belt!* As the surface wears, new friction is exposed with all the grip of a new belt—a surface that will not chatter or ball-up.

Months of service in typical operations have conclusively demonstrated 5-R's ability to reduce power transmission costs. Armored with a permanent, high coefficient of friction 5-R attacks cost on two fronts. **1.** *Lower tensions* in the belt itself, resulting in longer belt life and greater ability to hold fasteners. **2.** *Reduced bearing pressure*, resulting in longer bearing life, less lubrication problems, less frictional losses. It is now available in roll lots in all popular sizes and widths. The G. T. M.—Goodyear Technical Man—will be glad to give you full data on this unique new belt. To bring him to your plant, write Goodyear, Akron, Ohio, or Los Angeles, California—or the nearest Goodyear Mechanical Rubber Goods Distributor.

THE GREATEST NAME IN RUBBER

GOODYEAR

BOMBS . . . CRABS . . . and SURGEON'S GLOVES

Need DIFFERENT kinds of air

There is *one particular* inside climate best suited to the production of each kind of product. Gun powder, for example, needs a certain control of moisture to maintain the accuracy of burning rate and the accuracy of timing. The canning and packaging of crabs, codfish, shrimps calls for cooling and dehumidification to prevent the sea foods from picking up moisture. Still another variety of air-conditioning is necessary to eliminate blistering and weak spots in surgical gloves and other dipped rubber goods.

In over 30 years Parks engineers have supplied hundreds of different businesses with the air conditions best suited to each particular need. They have developed for Certified Climate the finest equipment for every kind of air conditioning requirement — large and small. They can certify *your* business climate—at a lower investment than you might believe.

Call in a Parks engineer. Talk with him about the certified climate — your air-conditioning problem. There is no obligation, of course, and you will find his suggestions valuable. Write for your "Guide To Those Who Must Outwit Climate."

PARKS-CRAMER CO., FITCHBURG, MASS . . . CHARLOTTE, N. C.

PARKS *Certified Climate*

3256

Bars of Known Quality

...IN A LOCAL WAREHOUSE

● Specify UNION Cold Drawn Steels when you order from your local distributor. You will get bars widely known for high quality for nearly half a century.

Union Drawn Distributors carry large, classified stocks of Union Cold Drawn Steels in standard shapes and a wide range of sizes. Filling your order is simply a matter of assembling the bars and loading on a truck. **Right out of the racks and on the way to you**—that is their brand of service. The time required is just a matter of distance and traffic conditions.

These distributors do more than carry stock. They are competent to advise on steel processes and steel uses. They serve their trade capably, backed by close mill cooperation and expert metallurgical assistance.

PROMOTE EFFICIENCY WITH

Union Cold Drawn Steels

So you're going MODERN

—which means more than scrapping obsolete machines, old-time line shafts, and ill-advised power-wasting small motors. In the larger sense, "going modern" today means *planned production*—scheduled and routed—and part of that picture is *Modern Group Drive.* This newer way of transmitting power to machines, combining the best of the two older systems (individual motor drive and line-shaft drive) interests every plant executive because it is *designed* for planned production.

★ ★ ★

Modern Group Drive calls for large motors for *groups* of machines and individual motors where required for *single* machines. With planned production this newer, more efficient system increases production and cuts costs. Compared to individual motor drive applied to machines indiscriminately throughout a plant, Modern Group Drive shows savings in installation, operation, maintenance and power costs that no business can afford to lose.

As a method of applying motor-power to production machines, Modern Group Drive is inherently more efficient because it uses *larger* motors with *better* power factor. These larger motors cost you from 35% to 85% *less* per motor horsepower. And you buy *less* motor horsepower for the same number of machines.

SEND FOR FREE BOOKLET

Our Red Book talks your language and tells with pictures and brief text why and where Modern Group Drive is more efficient and economical. Send for a copy today. Case studies are also yours for the asking. And at your call, without obligation, are Power Transmission Counselors throughout the country who cooperate with plant, consulting and public utility engineers in the modernization and installation of industrial power transmission systems.

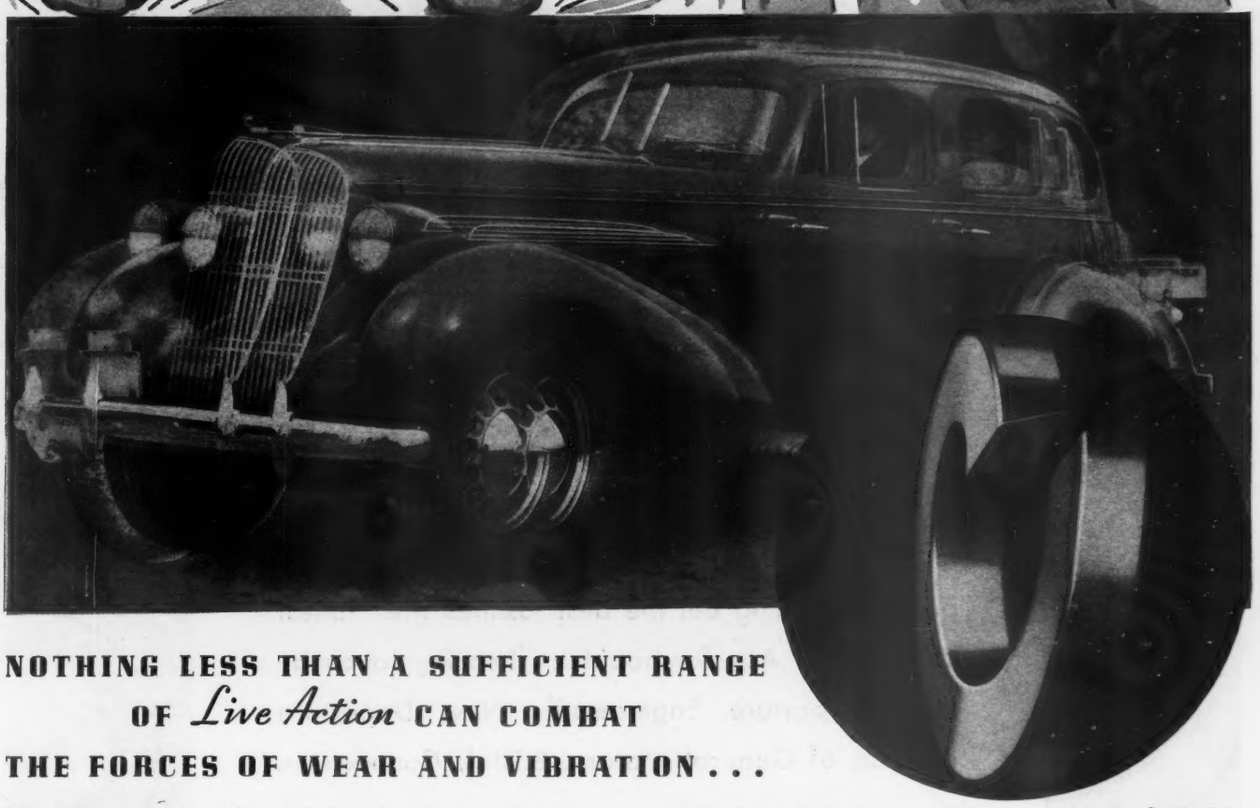
POWER TRANSMISSION COUNCIL
75 STATE STREET · BOSTON, MASSACHUSETTS
A research association of producers and distributors of power, power units and mechanical equipment for transmitting power.

MODERN GROUP DRIVE

MODERN GROUP DRIVE

—the *new* efficient and economical way of transmitting power to machines

THESE TWO *CAN'T BE FOOLED*



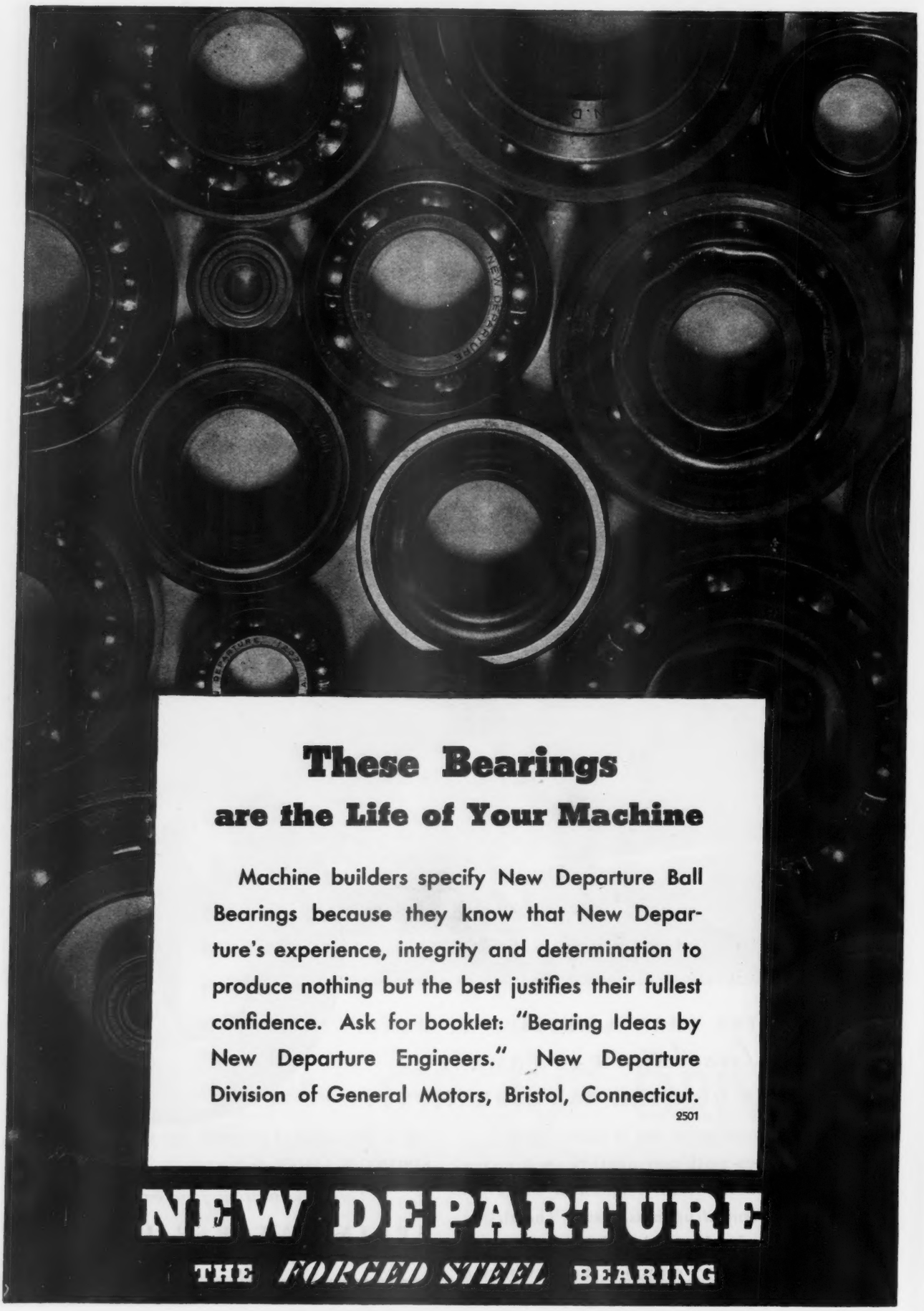
NOTHING LESS THAN A SUFFICIENT RANGE OF *Live Action* CAN COMBAT THE FORCES OF WEAR AND VIBRATION . . .

Theories may sound good but it takes action . . . *Live Action* to keep machinery tight! No bolt or nut ever loosened *initially* from vibration or shock because it *turned backwards* upon its threads. The friction and adhesion in the threads is infinitely more than enough to resist backward turning due to vibration and shock so long as the *pressures* set up by the wrenching in the original assembly *are maintained.* Only a SPRING WASHER *can do this.*

There is no substitute for a spring washer

SPRING WASHER INDUSTRY
616 WRIGLEY BUILDING, CHICAGO, ILL.

ONLY A SPRING WASHER HAS Live Action!



These Bearings
are the Life of Your Machine

Machine builders specify New Departure Ball Bearings because they know that New Departure's experience, integrity and determination to produce nothing but the best justifies their fullest confidence. Ask for booklet: "Bearing Ideas by New Departure Engineers." New Departure Division of General Motors, Bristol, Connecticut.

2501

NEW DEPARTURE

THE *FORGED STEEL* BEARING

E C PILLOW BLOCKS
FLANGE MOUNTINGS
UNIT TYPE PILLOW BLOCKS
NEW SEALING FEATURE
Above is shown the unique labyrinth closure and felt seal combination locking collar designed to revolve with the shaft as a flinger—one of the many new and remarkably efficient features of the C J B line which eliminates added cost of special seals and closures in ordinary applications.
TAKE-UP UNITS
BALL AND SOCKET PILLOW BLOCKS
HANGER BEARINGS

Now

. . . AND IN TUNE WITH PRODUCT AND PLANT MODERNIZATION NEEDS

The new C J B Transmission Units not only represent the most complete line offered by any manufacturer, but in addition one which embodies the only noteworthy improvements within the last two decades!

Imagine, for example, the advantages of being able to select from three distinct types of Pillow Blocks any one of nine different capacities for a given shaft size. This unusually wide range of capacities and types (see above) together with many other new and revolutionary features makes the C J B line the logical one to consider in your plant or product modernization programs.

Complete stock now carried by our 28 branches. Write for Catalog and address of nearest branch.

AHLBERG BEARING COMPANY

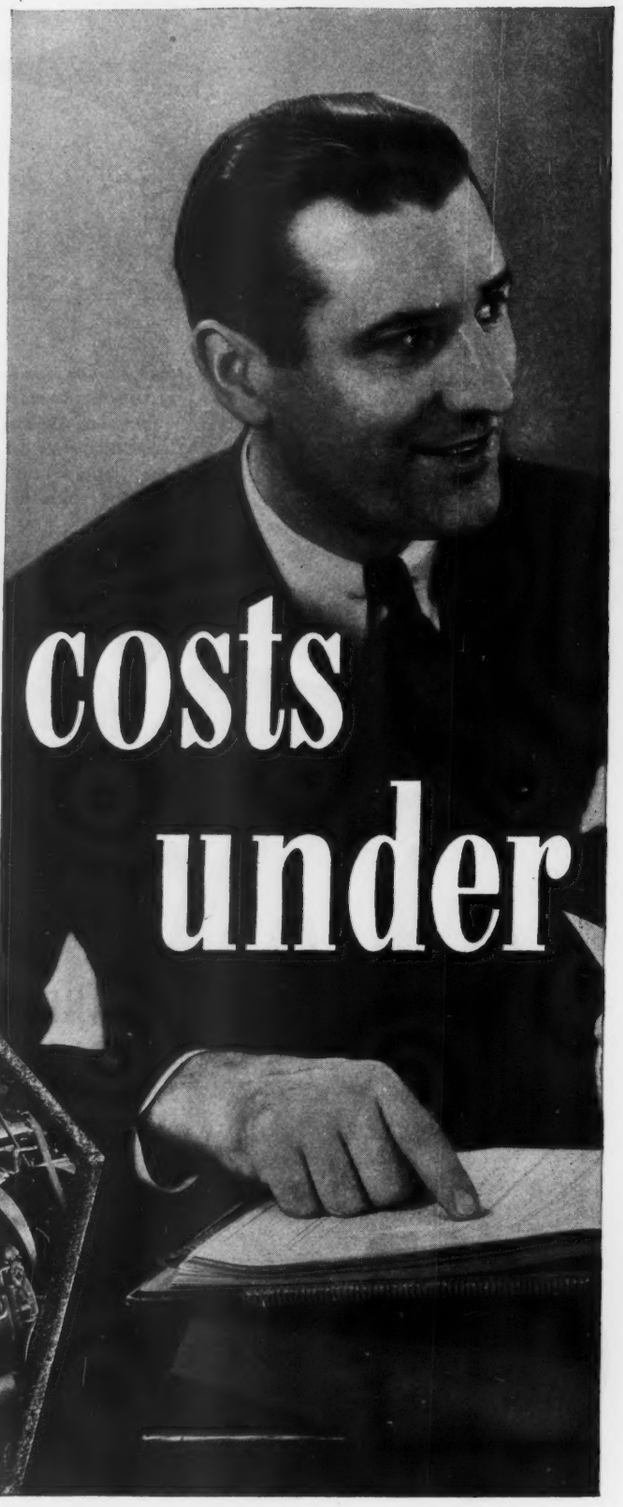
317 East 29th Street — Chicago, Illinois

C J B PILLOW BLOCKS

WRITE FOR YOUR COPY

Here is one of the most complete (and helpful) catalogs (ever) published on power transmission equipment. Every engineer and maintenance executive should have one on file. Write for your copy today.

TEXACO AT



costs under

WHEREVER production is up, maintenance costs down, another good job is being done, too. That's a lubrication job . . . all through the plant. How long has it been since *you* have checked up on your lubrication costs?

Texaco at work is effecting plant economies, power savings, lowered maintenance costs, improved machine operation in plants of every type.

And right here, Texaco engineers can help you.

These men have had long, practical experience in recommending lubrication practices that reduce costs.

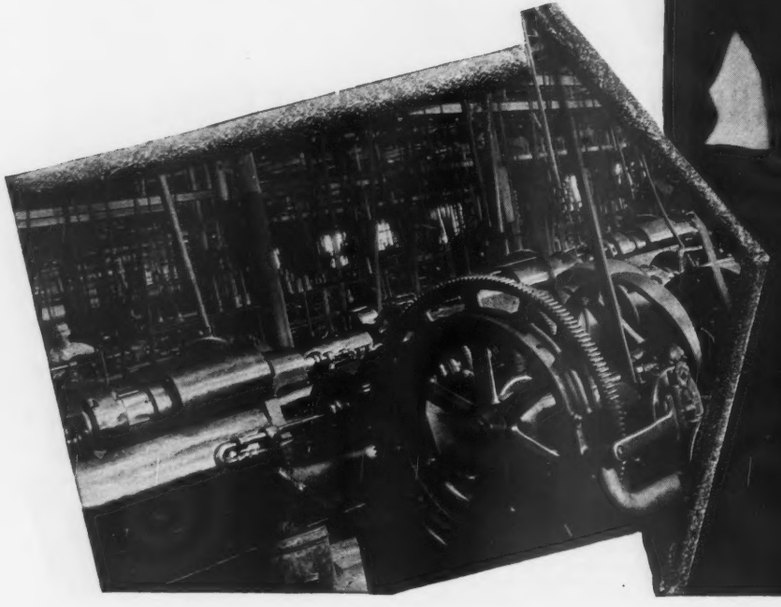
They bring you the background of advanced research, years of engineering development . . . and Texaco Lubricants for every specific condition.

Put your lubricating problems up to Texaco.

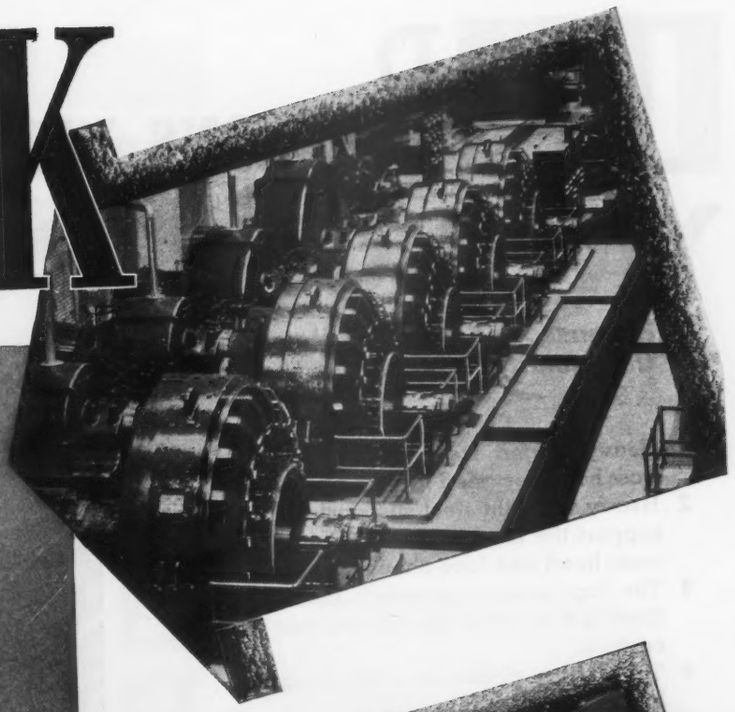
A Texaco representative will be glad to provide practical engineering service to prove the economies of Texaco Products.

THE TEXAS COMPANY · 135 E. 42nd St., N.Y.C.

Nation-wide distribution facilities assure prompt delivery



WORK



control

TEXACO

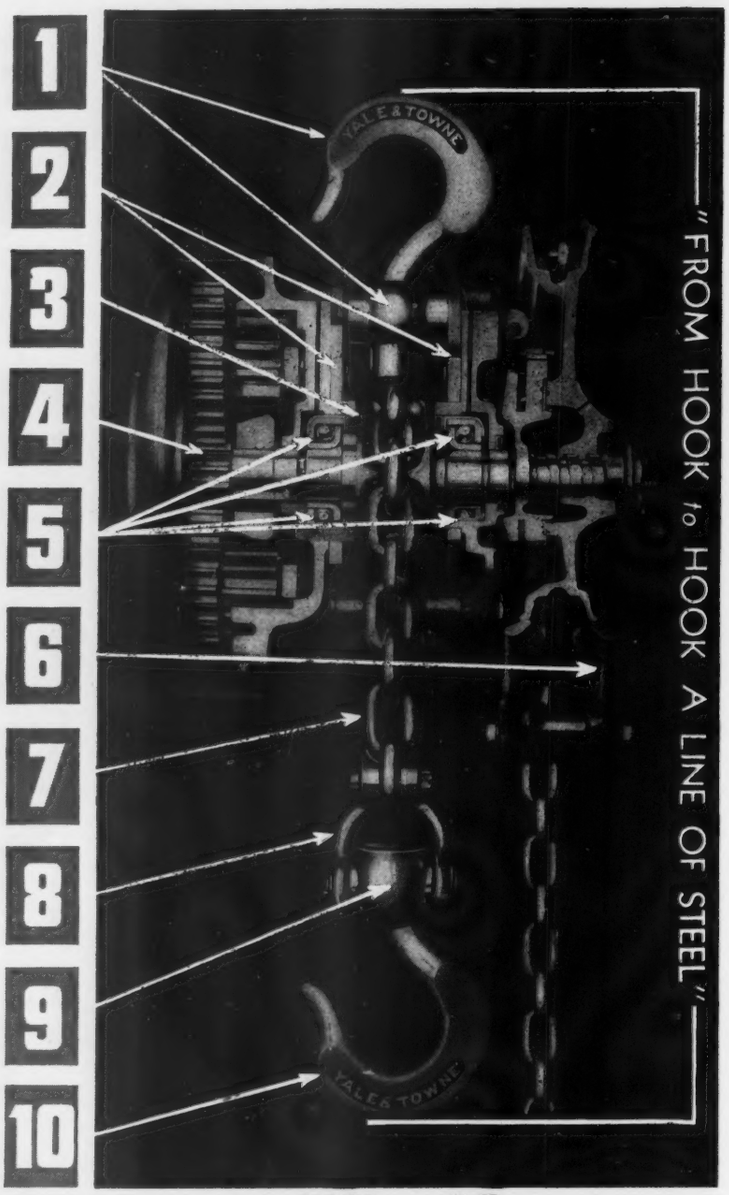
TEXACO

Industrial Lubricants

10 REASONS WHY BUYERS SELECT YALE CHAIN HOISTS

Because . . . Yale Chain Hoists have an international reputation for QUALITY and that quality is based on the outstanding features of construction, as follows:

1 Heavy forged steel safety hook and cross head designed to withstand shock.
2 Heavy wrought steel suspension plates support the load between the top hook cross head and load sheave.
3 The load sheave on which the load is lifted is a massive special analysis steel casting.
4 The driving pinion is a one-piece forging of special steel.
5 Ball bearings upon which the load sheave is mounted are of high carbon chrome alloy steel running in chrome vanadium steel races.
6 A continuous and adjustable hand chain guide prevents snagging—with a tensile strength of 50,000 lbs.
7 The load chain is of steel, welded and heat treated.
8 Drop forged two-piece shackles with heat-treated suspension pin permit changing or replacing load chain without welding.
9 Lower hook is equipped with heavy duty ball bearing, completely enclosed, packed in grease, requires no further lubrication.
10 Steel safety hook opens slowly without fracture before any other part of the hoist is overstrained—protects operator and load.



DISTRIBUTORS MAKE YALE HOISTING EQUIPMENT THE EASIEST TO BUY

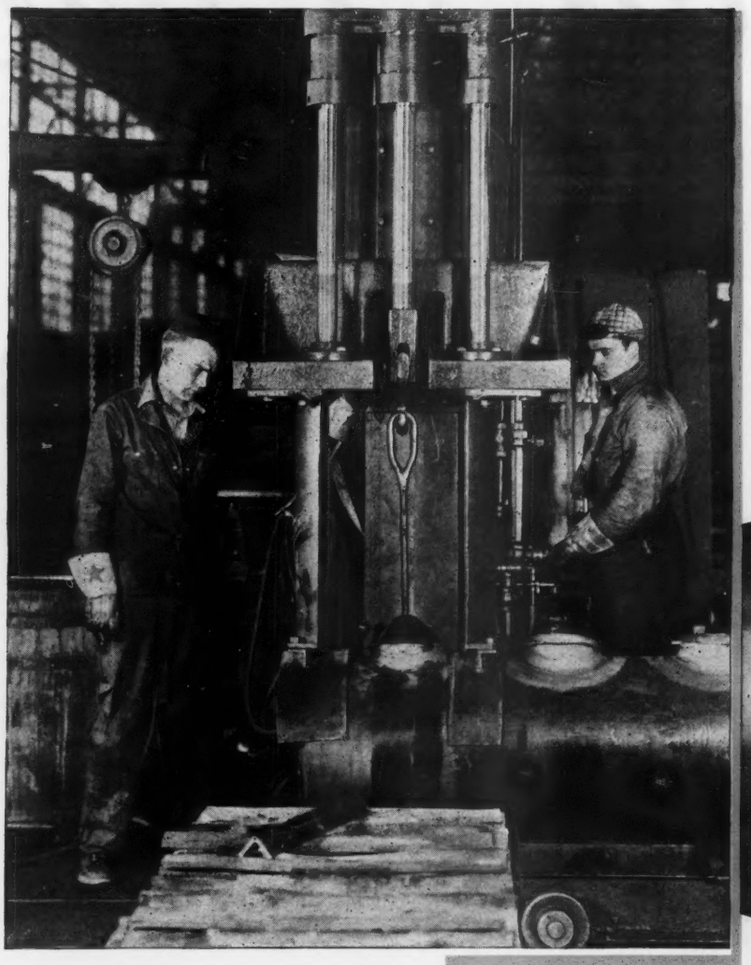
The Yale Distributor is no further away from you than your telephone. The hundreds of Industrial Supply organizations who feature Yale Products cover the entire country. In every industrial center they are business leaders, serving industry swiftly, efficiently and economically. Yale Chain Hoists and allied equipment are sold only through Yale Distributors—in order to provide American industry with the fastest, most satisfactory kind of service.

Capacities 300 Lbs. to 40 Tons

TRADE YALE MARK

THE YALE & TOWNE MFG. CO.
PHILADELPHIA DIVISION, Philadelphia, Pa., U. S. A.

THOUSANDS OF DOLLARS INVESTED



To Make Every Weld A Plain Butt Weld

Seven Reasons For Saying "Give The Plans To Grinnell"

KNOWLEDGE OF TODAY'S CONDITIONS
INTERPRETATION OF IDEAS AND PLANS
ADVANCED PLANT FACILITIES
THOROUGH TESTING
EASY, RAPID ERECTION
ECONOMY IN COST
ALL WORK QUALIFIED FOR INSURANCE

The above photograph, showing one of Grinnell's powerful extruding machines, gives meaning to the phrase, "advanced plant facilities". These giants represent thousands of dollars invested for just one purpose: to make every outlet in a Grinnell Prefabricated Piping installation a plain circumferential outlet, easily butt-welded by any qualified pipe welder. The smooth contours, accurate positioning of the nozzle, and uniform wall thickness that characterize Grinnell Prefabrication result from the use of these machines.

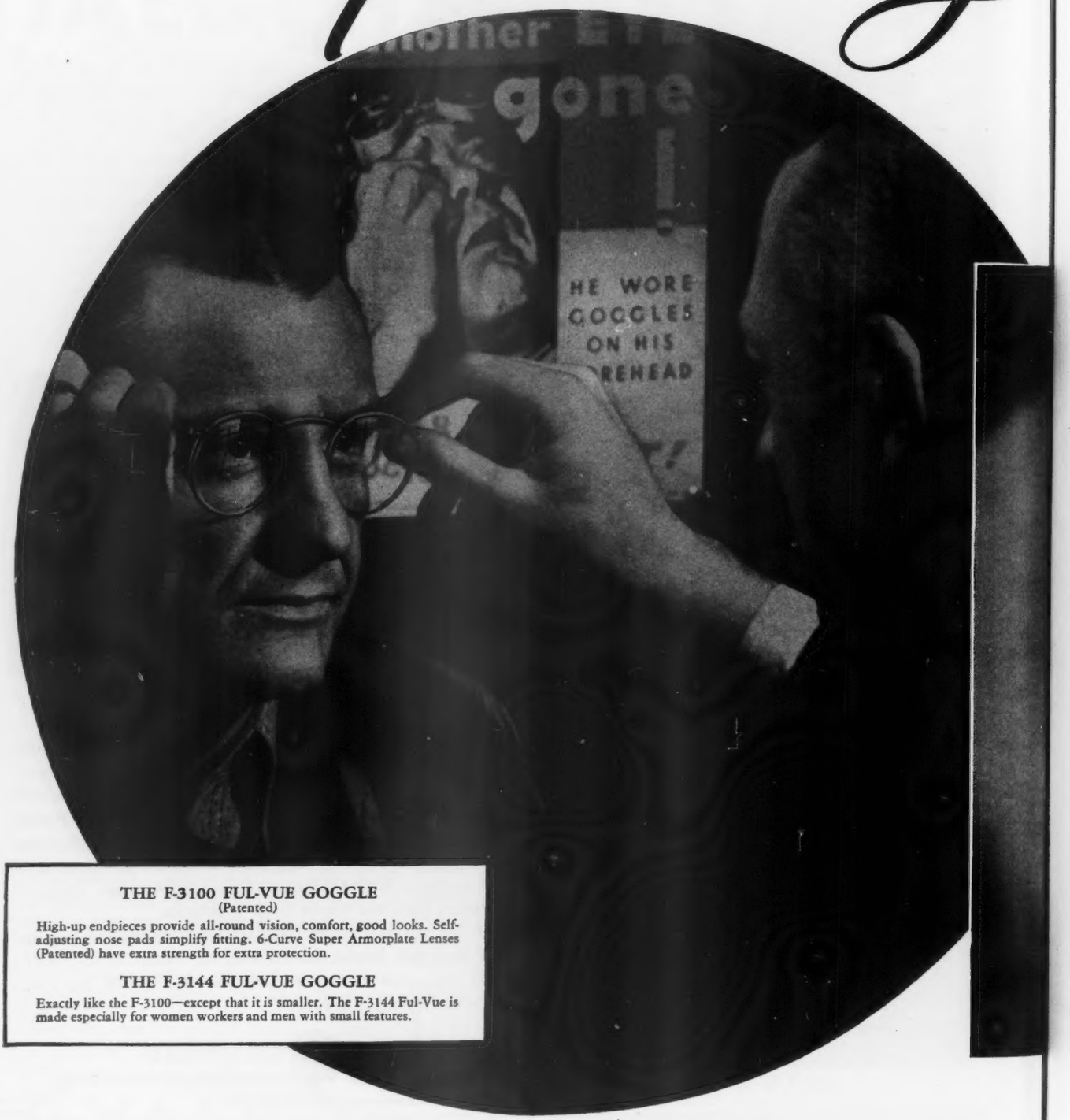
This is one of the unusual plant facilities that makes the finished job easier with Grinnell Prefabricated Piping. One of the seven reasons (see left) why experienced engineers advise, "Give the plans to Grinnell whenever piping is involved".

GRINNELL COMPANY
EXECUTIVE OFFICES PROVIDENCE, R. I.
Branch Offices in Principal Cities

GRINNELL

. . . WHENEVER PIPING IS INVOLVED . . .

You Pay



THE F-3100 FUL-VUE GOGGLE
(Patented)

High-up endpieces provide all-round vision, comfort, good looks. Self-adjusting nose pads simplify fitting. 6-Curve Super Armorplate Lenses (Patented) have extra strength for extra protection.

THE F-3144 FUL-VUE GOGGLE

Exactly like the F-3100—except that it is smaller. The F-3144 Ful-Vue is made especially for women workers and men with small features.

American Optical

Far Less FOR GOGGLES

. . . than for a Slightly Injured Eye

Two switches are thrown, two machines whine to a stop while one worker attempts to remove a particle from another worker's eye. Idle machine time, delayed production and workers' time soon exceed the cost of a pair of goggles . . . you pay for goggles whether you buy them or not.

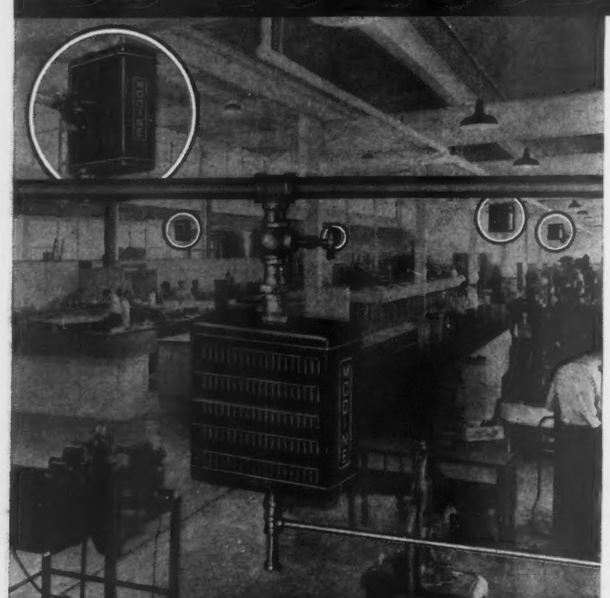
Save money by supplying goggles to every worker whose job contains even the slightest possibility of eye injury. One manufacturer recently estimated that goggles saved a worker's eye every 8 days and prevented countless minor eye injuries . . . saving his company about $100,000 a year.

Prevent eye accidents in *your* plant—and save money. American Optical Company has a complete line of eye protection equipment that gives a choice of 24 standard types. They are strong, cool, comfortable. In addition, the services of an American Optical Company representative are always available from a branch office near you to make your eye safety program most effective and profitable. Call in this man today.

Company

Manufacturers, for more than 100 years, of products to aid and preserve vision. Factories at Southbridge, Massachusetts. In Canada, Consolidated Optical Co., Ltd. Branch offices in all principal industrial centers

WHAT WILL 5° BELOW ZERO DO TO YOUR PRODUCTION?



MODINE UNIT HEATERS

● What will happen to your production if it is 5° below zero one week from today? Parts or all of your plant shut down? . . . unfilled orders? . . . ?

Of course, it probably won't happen *next* week. But in the next two or four weeks . . . the temperature *is* going to drop below zero in many localities. Will you get all the heat you'll need? Install Modine Unit Heaters *now* . . . get heat in a hurry . . . *when* you want it . . . *where* you want it.

On the coldest mornings, after a week-end . . . turn on the Modines and have heat . . . immediately . . . sufficient heat, thoroughly distributed . . . even temperature everywhere. Suspended from steamline overhead, Modines deliver heat downward . . . direct to working zones and floor where needed. No cold spots . . . no drafts.

Modernize with Modines . . . *step up* production, *improve* working conditions, *save* 13½ to 25% *and more* in fuel costs alone . . . earn an investment return for years to come. Find out why *more Modines are sold than any other unit heater!* Send for new Catalog 236.

MODINE MANUFACTURING COMPANY
1208 17th STREET RACINE, WIS.

HEATING, COOLING AND AIR CONDITIONING EQUIPMENT FOR INDUSTRIAL, COMMERCIAL AND DOMESTIC APPLICATION

...and Oil for the MINDS IN YOUR PLANT!
SOCONY-VACUUM Will Help Your Men Better the Work they do for You
YOU WILL FIND that your own men—those who know your problems best — will quickly find use in their daily problems for Socony-Vacuum's friendly cooperation and 70 years of practical experience.
Here, a valuable suggestion; there, a new idea, enable them to work out worth-while efficiencies and economies.
That is why thousands of plants—many in your own locality—will tell you one of the best reasons for doing business with Socony-Vacuum is the kind of help their men get. Try this in your plant and see!
SEE THE FOLLOWING PAGE...

EARN EXTRA PROFITS THIS WAY!

Socony-Vacuum helps Men and machines increase plant efficiency

WHERE YOUR MEN are handling several units, Socony-Vacuum is daily handling thousands. The knowledge and keenly practical experience thus gained we'll gladly pass on to your men—for your benefit.

With an enlarged knowledge of lubrication as it affects production volume, power, maintenance and oil costs, your men can devise valuable economies. Give them this chance by talking with Socony-Vacuum.

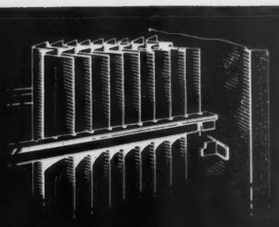
SOCONY-VACUUM OIL CO.
INCORPORATED

STANDARD OIL OF NEW YORK DIVISION · WHITE STAR DIVISION · LUBRITE DIVISION · WHITE EAGLE DIVISION
WADHAMS OIL COMPANY · MAGNOLIA PETROLEUM COMPANY · GENERAL PETROLEUM CORPORATION OF CALIFORNIA

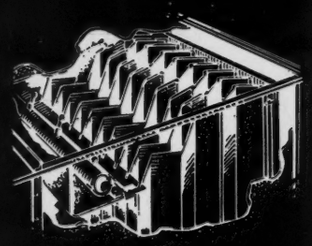
GARGOYLE
Lubricants

LOW COST DUST ELIMINATION

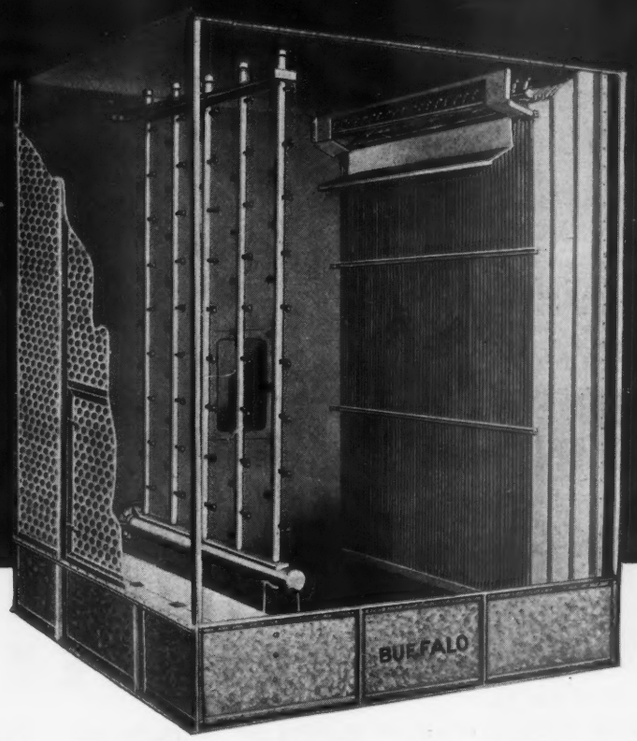
EFFICIENT DUST RECOVERY

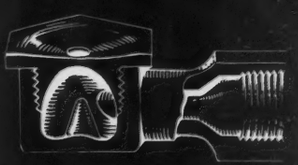


Details showing how Buffalo Air Washer eliminator plates are assembled in the washer. Cleaning and painting is easy with this arrangement of plates.



Section of Buffalo Air Washer with part of casing removed showing eliminators in position. Note patented construction of these eliminators.





Section of Buffalo Spray nozzle showing the absence of moving parts and smooth interior construction providing uniform spray over large areas.

"Buffalo"

AIR WASHERS

Buffalo Air Cleaning Equipment provides a simple, highly efficient and economical means for continuous elimination, and recovery where necessary, of industrial dusts.

The Buffalo Spray Nozzle, having no moving parts and large non-clogging passages, still gives a spray so fine and dense that foreign particles are thoroughly wetted for complete precipitation on the scrubbing surfaces of the eliminators.

Buffalo one-piece demountable eliminators can be installed, cleaned and repaired with a minimum of labor.

Buffalo Air Washers are available in full range of types and capacities to meet the requirements of industry.

In the chemical plant, Buffalo Gas Scrubbers are used to remove the dusts, metallic fume, tar vapor and other contaminations from valuable by-product gases, frequently saving enough on maintenance costs alone to pay for the equipment.

Competent engineers located in Buffalo branch offices throughout the country are ready to recommend installations accurately fitted to your own special requirements.

BUFFALO FORGE COMPANY, 471 Broadway, Buffalo, N. Y.

In Canada: Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

Branch Offices:

ALBANY, 611 Standard Bldg.; ATLANTA, 724 First National Bank Bldg.; BOSTON, 486 Main St., Melrose Sta.; CHARLOTTE, J. W. Fraser & Co., 124 Brevard Court; CHICAGO, 20 No. Wacker Drive; CINCINNATI, 622 Broadway; CLEVELAND, 410 Rockefeller Bldg.; DALLAS, 315 South Harwood; DAVENPORT, 305 Security Bldg.; DENVER, Hendrie & Bolthoff Mfg. & Sup. Co., 1635 Seventeenth St.; DES MOINES, 214 Old Colony Bldg.; DETROIT, Coon DeVisser Co., 2051 W. Lafayette Blvd.; GREENVILLE, George R. Morgan, 316 Walker Bldg.; KANSAS CITY, 315 Dwight Bldg.; KITCHENER, ONT., Canadian Blower & Forge Co., Ltd.; KNOXVILLE, C. F. Sexton, 315 Empire Bldg.; LOS ANGELES, 708 Pershing Sq. Bldg.; MINNEAPOLIS, 619 Foshay Tower; NEW ORLEANS, Devlin Bros., 1003 Maritime Bldg.; NEW YORK, 39 Cortlandt St.; PHILADELPHIA, 220 S. Sixteenth St.; PITTSBURGH, 431 Fulton Bldg.; SAN FRANCISCO, Moore Machinery Co., 550 Fifth St.; ST. LOUIS, 1596 Arcade Bldg.; SALT LAKE CITY, Salt Lake Hdwe. Co.; SEATTLE, 500 First Ave., S.; TOLEDO, 1922 Linwood Ave.; TUCSON, ARIZ., Tidmarsh Engrg. Co.; WASHINGTON, D. C., 820 Woodward Bldg.

● To protect shipments of parts, accessories, etc. of Studebaker passenger cars and commercial vehicles to branches and dealers Studebaker uses SIGNODE Steel Strapping. According to that company money has been saved in labor, time and freight rates, shipping at the rate of over 100 SIGNODE Steel Strapped containers daily.

STRAPPED TO ARRIVE IN *Good Shape*

● Whether it be a small package, a bundle or a hundred-thousand pound load, the protection and reinforcement of SIGNODE Steel Strapping keeps tight control of it from the plant to the buyer. In absorbing transit shocks SIGNODE Steel Strapping is to a shipping container what steel hoops are to a barrel.

In addition to protecting SIGNODE Steel Strapping makes it possible to do away with heavy, expensive packing and lighten and economize practically every type of shipment.

To find out if there are any ways of reducing your shipping and packing costs or improving your containers have a SIGNODE Packing Engineer call or send for Catalog 17-A.

SIGNODE STEEL STRAPPING CO.
2621 N. Western Ave., Chicago, Ill.
361 Furman St., Brooklyn, N. Y.
452 Bryant St., San Francisco, Calif.

SIGNODE
Better Packing Headquarters

RECORDS!

WITH *Paasche* AIRFINISHING EQUIPMENT

●Wherever finishing is a production problem, Paasche is more than a name. Paasche represents a service of invention and special design, producing short cuts to production peaks—superior finishes—lowered costs, with airfinishing equipment. Here are 5 examples of Paasche ingenuity—and 5 resulting records.

$6,000.00 saved in Lacquer Alone!

Eighteen months ago lacquering of smokers' pipes was an involved production problem. Paasche solved it with the equipment pictured at the top—an aircoating machine used by 6 leading pipe manufacturers who now enjoy peak production—highest quality—*and savings on lacquer alone of as much as $6,000.00 a year.*

Paasche Airbrush Co.

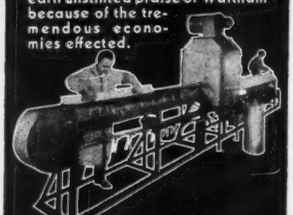
1901 DIVERSEY PARKWAY, CHICAGO, ILL.

Pioneers in Automatic and Manual Airpainting, Airrubbing, Aircoating, Airdusting, Airpolishing, and Ventilating Methods

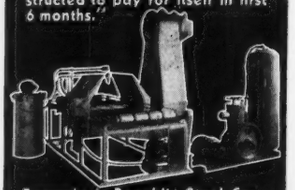
Paasche manual airequipment leads the industry. This BURF high production airbrush is representative of the complete line.

All types, all sizes. Features speed, coverage, easy handling and unequalled low maintenance costs.

Example 2: Three Automatic airfinishing and drying units like this used by Waltham Watch Co. for coating dials, clock cases, etc., earn unstinted praise of Waltham because of the tremendous economies effected.

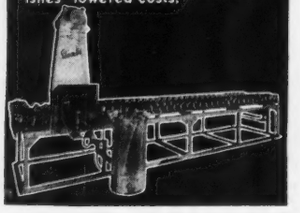


Example 3: Coats and dries 9,600 small electric motors per hour for Delco Appliance Corp. (General Motors Div.) "Designed and constructed to pay for itself in first 6 months."



Example 4: Republic Steel Corporation lacquer-coats metal sheets in carload lots with this special Paasche automatic installation.

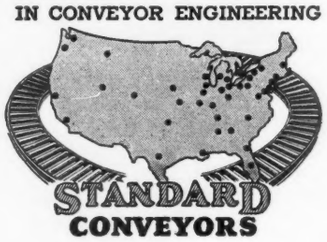
Example 5: This Paasche equipment aircoats metal and wood slats for Kirsch Co., venetian blind manufacturers. "Better finishes—lowered costs."



. . . WITH LOWER MATERIAL HANDLING COSTS . . .

Mentholatum cartons sweep swiftly to the shipping room on a Standard Belt Conveyor

A NATION-WIDE SERVICE IN CONVEYOR ENGINEERING



THAT ever-narrowing margin between costs of production and profits can be widened. Begin with the handling of material—both raw and finished—and analyze it. Here is a vital connecting link between men, material, machines and finished product where wastes can be plugged and important economies effected.

As a first step call in a Standard Conveyor Engineer . . . a qualified expert on planned material handling. His experience will aid you to plan your material handling . . . reduce its cost—pull profits out of what may seem inescapable expense.

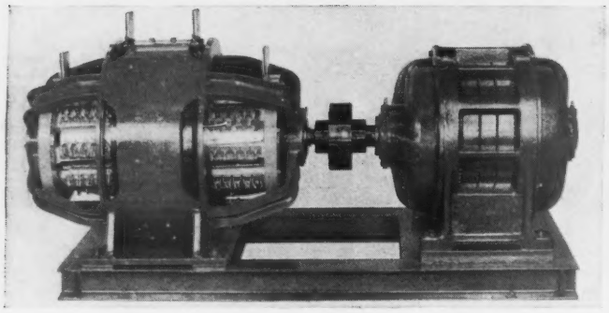
Standard has served many of the nation's leading manufacturers in this way for over thirty years . . . and Standard is ready to serve you.

"Conveyors by Standard" MF-12—a valuable reference book on conveyors and conveying methods. Sent free to plant and production executives.

STANDARD CONVEYOR COMPANY

GENERAL OFFICES: NORTH ST. PAUL, MINN.

MODERN . . DEPENDABLE



When you consider Low-Voltage Generators, ask yourself these questions.

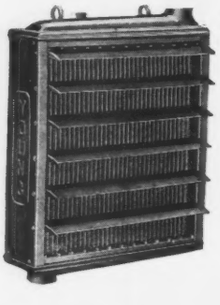
Do the design and construction insure

1. **Long brush life?**
2. **Low maintenance cost?**
3. **Ready accessibility?**
4. **Trouble-free bearings?**

You get all of these features and many more in a Columbia Low-Voltage Generator. Write for the bulletin describing them.

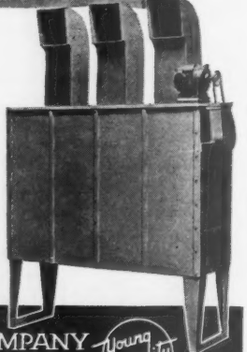
COLUMBIA ELECTRIC MANUFACTURING CO.
4515 Hamilton Ave. Cleveland, Ohio

COLUMBIA LOW VOLTAGE GENERATORS



UNIT HEATERS – BLAST HEATERS – COMMERCIAL HEAT TRANSFER SURFACES

MODERNIZE YOUR HEATING PLANT WITH Young UNIT HEATERS



Either the suspension or floor models will provide a most satisfactory and economical method of heating all types of industrial buildings. Young Blast Units and Commercial Units are designed to operate in conjunction with central fan systems for either heating, cooling, or air conditioning. All Young heating and cooling units are available in many sizes and capacities to fill the most exacting specifications.

OFFICES IN ALL PRINCIPAL CITIES

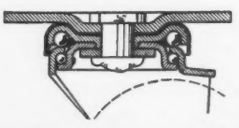
YOUNG RADIATOR COMPANY
RACINE, WISCONSIN
Young Quality

Darnell E-Z Roll Wheels enable truckers to carry heavier loads with greater ease and give maximum protection to floors.

Eliminate the "Afternoon Energy Lag" with DARNELL Casters & Wheels

Production schedules are more easily maintained, efficiency is materially increased and accidents are largely eliminated when your workmen are freed from the "afternoon energy lag."

The unusual easy swiveling and rolling qualities of Darnell Double Ball-Bearing Casters and wheels effect many direct and noticeable economies that make their installation in your plant a matter of first importance.



A complete line of light, medium and Heavy Duty Industrial Casters.

NOTE DOUBLE BALL-BEARING DUST-PROOF SWIVEL—which not only provides easy swiveling under all conditions but increases the life of floors and equipment. The upper set of ball-bearings carries the load weight; the lower row takes up all lateral stress. Only Grade "A" balls are used, rolling in hardened and carbonized raceways.

Always SWIVEL and ROLL

Write us your caster problems. Darnell engineers will gladly confer with you in their solution. Write for Illustrated Literature.

THE NEW DARNELL CASTER AND WHEEL MANUAL NOW READY FOR DISTRIBUTION

DARNELL CORPORATION, LTD.

Box 4027, Sta. B, Long Beach, Cal.

36 N. Clinton St. CHICAGO, ILL.

24 E. 22nd St. NEW YORK, N. Y.

EVERY BUSINESS NEEDS A *PRIVATE* TELEPHONE SYSTEM

P-A-X WILL STOP THIS WASTE

Interior communication by old-fashioned foot power is not only obsolete. It is costly as well.

Yet the smooth working of any organization requires constant exchange of information. Questions, answers, instructions *must get through*—quickly and without error.

The P-A-X (Private Automatic Exchange) provides this essential service. It affords instant contact by telephone throughout your entire plant. It encourages *talking* instead of *walking*. It conserves steps, time and energy of your whole personnel, from president to office boy.

Your city telephone service is improved too. Your switchboard is no longer clogged by inside calls. Your operator is left free to concentrate on outside traffic.

Nearly 2000 organizations in every line of business use the P-A-X to help their employees get more done in less time. Our representative will be glad to explain how the P-A-X will increase *your* profits.

STUDY THESE P-A-X FEATURES

- ***Automatic Connections*** — No operator; mechanical speed and precision; twenty-four hour service.
- ***Provides "Double-Track" Service*** — Your caller on the city line can "hold the wire" while you talk over the P-A-X.
- ***Modern Equipment***—P-A-X telephones are constructed to public exchange standards.
- ***Convenient to Use*** — No push buttons; standard dial operation.
- ***Reduces Public Telephone Expense*** — Time of your switchboard staff is made available for other duties.
- ***Simple to Install***—Only two wires from each telephone to the P-A-X switchboard.
- ***Provides a Variety of Special Services***— Including Code Call, Conference, Executive Right-of-Way, etc.

AUTOMATIC ELECTRIC
TELEPHONE, COMMUNICATION AND SIGNALING PRODUCTS

Distributed by AMERICAN AUTOMATIC ELECTRIC SALES COMPANY, 1033 West Van Buren Street, Chicago, Illinois
In Canada: Canadian Telephones & Supplies Limited, Toronto
Sales and Service Offices in Principal Cities

Average Weeks Awarded per Case 6.7

There is a valuable object lesson for plant managers and superintendents in these figures drawn from a year's report of a single state. (Bulletin N. Y. Dept. of Labor, 1936.)

No matter how willing a man is to pull his heart out, carry his weight in pig iron, or any other proof of loyalty, you can't afford to let him do it! . . . If you can stand the insurance costs, the bill still doubles and trebles with the constant time losses—only a few seconds here and there but repeated hundreds of times in a working day.

One of the easy measures of protection is to standardize your heavy duty hauling over Service Casters of full bearing frictionless construction, and Service-castered trucks like the Service Push-E-Z.

If this sounds reasonable we don't ask you to sit back and reflect on it now. Just have one of the girls in your office write us for the facts about industry's easiest and longest rolling wheels—SERVICE CASTER & TRUCK CO., 519 N. Albion St., Albion, Mich.

The peer of all heavy duty floor trucks—Push-E-Z—with a welded channel steel frame and of course, Service Casters. In the Hyatt Bearings and hardened ball raceways, hundreds of small bearing surfaces share the load, with no excess on any one.

SERVICE

PUSH-E-Z-TRUCK AND SERVICE CASTERS

Increase the

MAN POWER

rating of your business

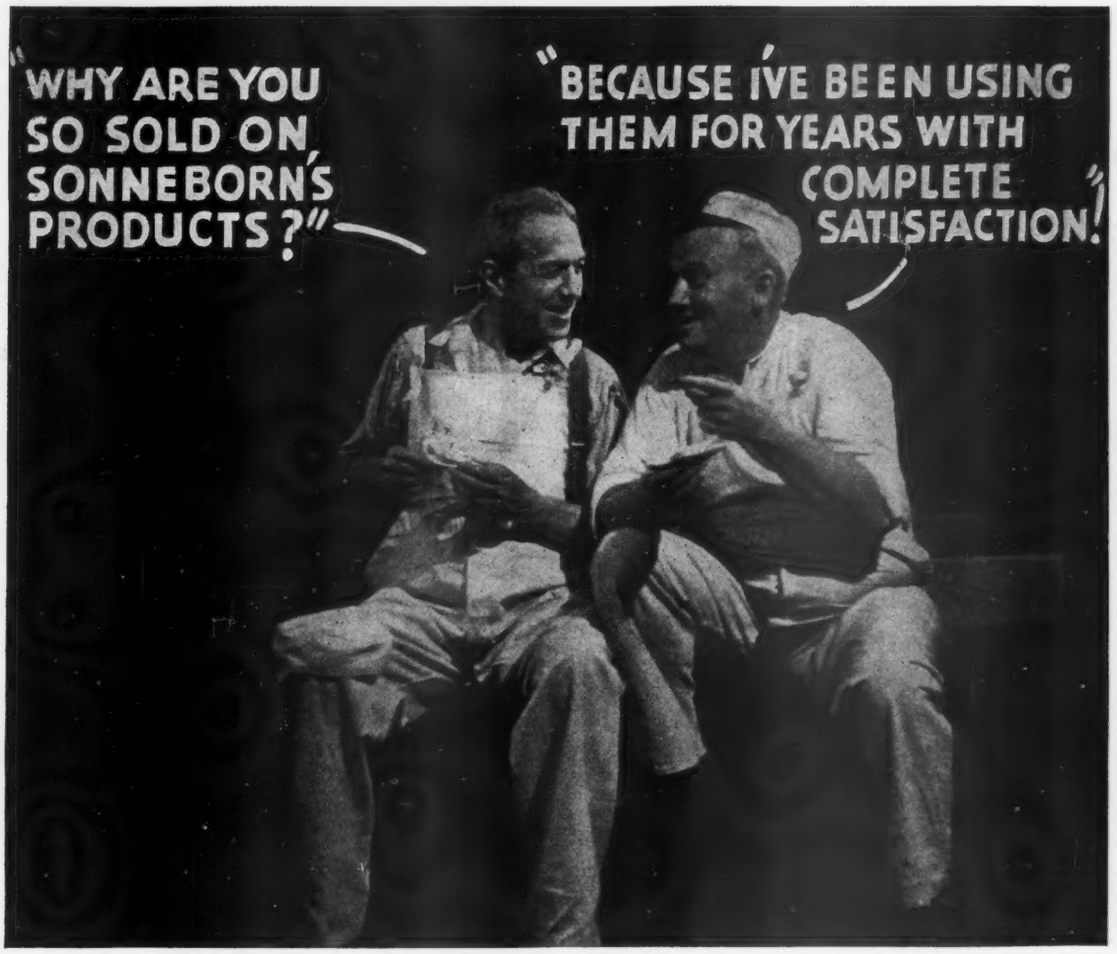
BACK of every business success is the human element. No organization with a poorly selected personnel can be long successful. No organization with a wisely chosen body of employees can be anything but successful.

Every man who goes on your payroll should be employed only after a rigid weeding out process. An advertisement in *Factory Management and Maintenance* is the first step toward eliminating the undesirables, for only sincere, intelligent, and forward looking men read this paper regularly. They are the kind of men you want in your employ. They are the kind of men you *must* have if *your* business success is to be assured.

Take the first step toward increasing the MAN POWER rating of your business by using the employment advertising service of *"Factory."*

Address
Departmental
Advertising Staff

330 West 42nd St.
NEW YORK, N. Y.



Lunch Time can Make or Break a Product

Listen to the men who work with a product if you want to get the "inside story" on its worth.

Ask them about SONNEBORN'S Tested Products. They will tell you that they have used them for years with utmost satisfaction under all types of conditions in all types of buildings; and they will also tell you that experienced representatives are always "on the ground," ready to be helpful in many ways that will save you time and money.

Plant superintendents, architects and builders too, have used and recommended SONNEBORN'S Tested Products for many, many years with utmost confidence in their dependability and quality.

SONNEBORN'S complete engineering department is always available to discuss any plans on Waterproofing, Dampproofing or Paint problems. This is a service cheerfully offered without obligation to you.

Write today for complete literature on SONNEBORN'S Tested Products.

Sonneborn's Tested Products

LAPIDOLITH
The guaranteed method of securing dustproof concrete floors.

LIGNOPHOL
A scientific penetrating preservative and finish for wood floors.

HYDROCIDE COLORLESS
For exterior waterproofing of masonry walls.

SONOMEND
For patching and resurfacing wood and concrete floors; an easy to use method for prolonging the use of floors.

KAUKIT
Non-shrinking waterproof caulking compound.

CEMCOAT
Light reflecting enamel for interiors also waterproof coating for exteriors and floors; is outstandingly superior for masonry surfaces.

CEMENT FILLER AND DUSTPROOFER
Double service plus decorative floors; a penetrating, tough, flexible floor coating of outstanding performance.

STORMTIGHT
Roof protection; a name that guarantees maximum roof protection at minimum cost.

S. R. P.
Rust protective coating for metal surfaces; paint over rust without expensive preparation.

L. SONNEBORN SONS, INC. 88 Lexington Ave., New York City

COLD SPOT CURE

with

TRANE UNIT HEATERS

Smother That Cold Spot With A Trane "Cradle Coil" Unit Heater

If there is a cold spot in your plant that men shy away from or where they aren't working up to par —then that spot needs a Trane Unit Heater.

Is there a door, continually opened, that chills the area around it? Blanket it with heat flowing from the attractive grille of a Trane Unit Heater.

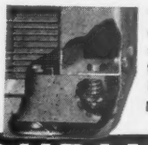
Are you trying to heat part of your plant with pipe coils that rocket the warm air to the ceiling? Then, especially you need Trane Unit Heaters that spread the heat evenly, where you want it.

The Trane "Cradle Coil" Unit Heater is a sure cure for those cold spots. It has Floor Line Spread exclusively. All the heat flows in the working zone. None is wasted at the ceiling.

And when you buy Trane, you have a Unit Heater that will give years of excellent service. The coil is cradled on springs. It expands and contracts freely.

Cure that cold spot with a Trane "Cradle Coil" Unit Heater. Write for the interesting bulletin that gives more details.

A Coil Cradled in the Casing



The coil is cradled on a spring in the casing. It rides the pipe lines.

THE TRANE COMPANY

La Crosse, Wis. - - - 65 U. S. Branches
In Canada: Mowat & King Sts. W., Toronto

Gentlemen: Please rush complete data on Trane "Cradle Coil" Unit Heaters.

Name_____

Address_____

_____

F12

FOR PROCESS STEAM CONTROL

MULTIPORT BACK PRESSURE VALVES ARE SAFER

Constant control of steam back pressure and atmospheric relief by the Cochrane Multiport Back Pressure Valve eliminates the possibility of explosion and does away with carrying excessive back pressure.

Cochrane Multiport Back Pressure Valve

Multiple valve discs provide instant response and there is no chatter or seat-pounding. No hammer.

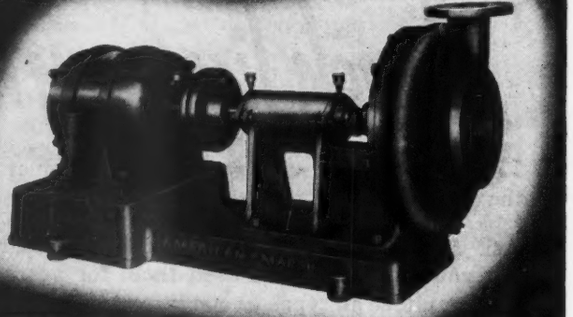
Maximum load may be predetermined and adjusted by hand wheel, chain wheel, or remote motor control.

Write For Publication 2517

COCHRANE CORPORATION
17th & Allegheny Ave. • Philadelphia, Pa.

COCHRANE

AMERICAN-MARSH



TYPE-R CENTRIFUGAL PUMPS

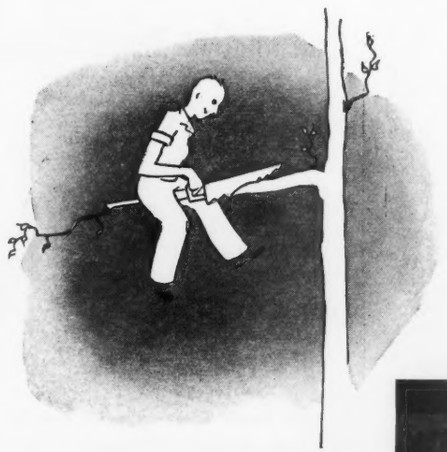
They Have Everything
. . . Except High Price!

• The last word in Low Priced Centrifugal Pumps . . . Ball Bearings! . . . Remarkably High Efficiencies! . . . Extra Heavy, Extra Dependable Construction in every part!

• Use these American-Marsh Type R Pumps for practically any pumping job, handling any liquid. USE THEM TO SAVE MONEY IN BOTH FIRST AND OPERATING COSTS. Available in a wide range of sizes for any type of drive.

• Write for Bulletin 300. Better still, have our engineers submit a recommendation covering your requirements.

AMERICAN STEAM PUMP COMPANY
BATTLE CREEK, MICHIGAN . . . Pumps and Pumps Only Since 1873



YOU'RE NOT BEING CARELESS ARE YOU?

THE building owner who puts *wood roofs* on a building that otherwise meets fire-safety requirements — with concrete foundations, concrete, brick or stone walls, steel beams, steel sash, etc. is defeating his own purpose.

The cost of a fire-safe roof-deck is no longer prohibitive. GYPSTEEL PLANK*, the modern fire-safe structural unit, ready for immediate installation, as easy to handle as lumber, has brought the cost down to approximately that of wood. If you are planning any kind of industrial building or roof replacement consider the advantages of using PLANK. PLANK is low in price, quick to erect, reduces labor costs, saves time and trouble and is not only fire-safe but vermin-proof, termite-proof, highly insulating. Make that building of yours fire-safe *all the way through.* Write for our BULLETIN giving full information about PLANK.

AMERICAN CYANAMID & CHEMICAL CORPORATION
Structural Gypsum Division
32 ROCKEFELLER PLAZA, NEW YORK, N. Y.

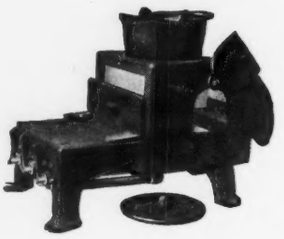
** The term PLANK as applied to cementitious building products is a registered trade-mark of the American Cyanamid & Chemical Corporation.*

GYPSTEEL PLANK is a complete structural unit shaped like lumber. Made of extra dense, nailable Gypsum. All four sides are bound with galvanized copper-bearing steel tongues and grooves which lock to form a strong, continuous I-BEAM. Center is reinforced with steel wire mesh. Vermin-proof, termite-proof. PLANK will not shrink or warp.

THINGS TO DO TODAY
Send for New Rockbestos Catalog! Shows complete line of asbestos insulated wires, cables and cords, made to new standard specifications. Write Rockbestos Products Corp., 833 Nicoll St., New Haven, Ct., giving:
name
title
company
address

Fill in, tear off and mail today

Johnson No. 118 Combination Bench Furnace



Here is one of the most outstanding Combination Bench Furnaces ever manufactured. Designed especially for heating the largest soldering coppers, branding irons or stenciling irons; tempering, annealing, case-hardening or soft metal melting. Equipped with three powerful Johnson Bunsen Burners and produces a quick, intense, uniform heat without a forced air blast. Sturdily constructed, compact, and built to give years of highly satisfactory service. Efficient and economical to operate. Full details sent on request.

JOHNSON GAS APPLIANCE CO.
Cedar Rapids, Iowa

Western Representative:
C. B. BABCOCK CO.
135 Bluxome Street
San Francisco, Calif.

Eastern Representative:
J. H. McPHERSON
250 Stuart Street
Boston, Mass.

Do You Read a Routed Copy?

If you are on a route list to read Factory Management and Maintenance, you probably pass it along without having the chance to read just the article that you would like best. Routed copies have a knack of arriving at inconvenient times—late—and often in poor condition.

Why not have your own copy delivered to you each month? Then you could read at your leisure—and while the news is still hot. A subscription costs only $3.00 per year. Send in yours now.

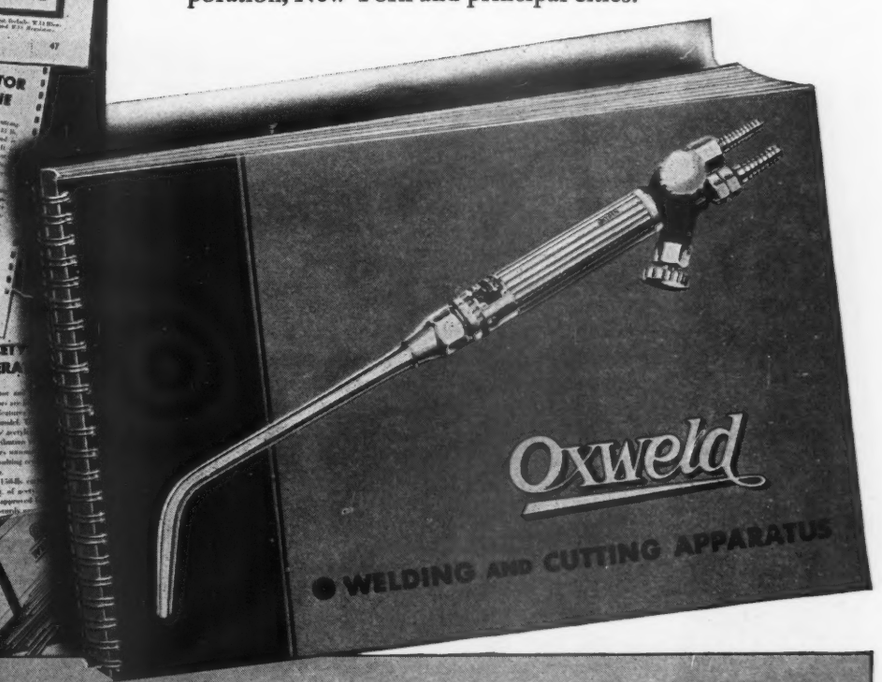
FACTORY MANAGEMENT *and* MAINTENANCE
330 West 42nd Street, New York City

The Line of OXWELD APPARATUS *is complete*

THE OXWELD line includes efficient equipment for every need of the oxy-acetylene process . . . acetylene generators, oxygen and acetylene manifolds, regulators, hand and machine welding and cutting blowpipes, automatic machines for shape-cutting, testing machines, and a complete range of accessories and supplies which includes an Oxweld Welding Rod for every need.

A welding and cutting outfit for any purpose can be made up from Oxweld equipment by selecting the Oxweld items specifically intended for the range of work you have to do. You are not limited by so-called standard outfits, but can exactly suit your own needs.

For complete information on Oxweld apparatus ask the nearest Linde office to send you a copy of the illustrated book "Oxweld Welding and Cutting Apparatus." The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation, New York and principal cities.



Everything for Oxy-Acetylene Welding and Cutting

LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES FROM UCC LINDE UNION CARBIDE

PRODUCTS OF UNITS OF UNION CARBIDE AND CARBON CORPORATION

"Switch on that CHROMALOX HEATER—

it's getting chilly here"

Of course you *can* keep your fireroom force on the job to provide heat whenever some department in your plant has to work overtime. But how much easier and cheaper to switch on one or two Chromalox-equipped heaters, and release the fireroom force with the quitting whistle.

How easy, too, to use these same efficient unit heaters to supplement the main heating system, when sub-zero days threaten your production. Every shop has cold spots—find them *now*, and warm them up.

And remember—no spot is too remote, too difficult of access, for a Chromalox-equipped electric unit heater. They fit in easily where steam lines cannot go.

●

You can heat anything industrial with Chromalox Electric Heating Units. They are made in types and sizes for all heating purposes—air, all kinds of liquids, parts of machines, processes. Hundreds of manufacturers have found that electric heat, with a compact, safe economical installation of Chromalox units, meets needs never before properly solved. If you have a situation of this sort, Wiegand engineers will gladly help you. All they need is a pencil sketch and description of the condition.

●

Keep the Chromalox Book of Electric Heat handy. It holds the answer to most electric heat questions. Use the coupon to get your copy.

Chromalox Electric Unit Heaters are described in detail in the Chromalox Book of Electric Heat.

Mail with your business letterhead

EDWIN L. WIEGAND CO.
7518 Thomas Blvd., Pittsburgh, Pa.

Without obligation, send me the CHROMALOX BOOK of ELECTRIC HEAT and details about CHROMALOX Unit Heaters.

Name .....

Position .....

Leading THE PLASTIC PARADE

A careful examination of the month in and month out flow of jobs bearing the Auburn label shows facts of vital interest to you.

Our ability to do the unusual in precision work has been proved repeatedly. When this experience is applied to less complicated forms it brings results of equal caliber. Our many years of molding experience gives you the benefit of cost-reducing short cuts—is your guarantee of the lowest price consistent with high grade work.

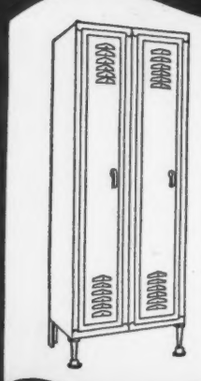
The right molding connection benefits every one in your organization. Let us quote on your next job.

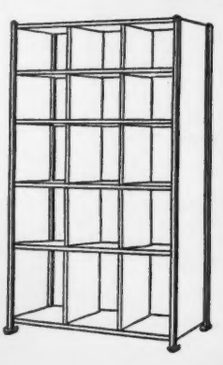
Established 1876

AUBURN BUTTON WORKS, Inc.
AUBURN, N. Y.

MEDART

STEEL LOCKERS *and* **STEEL SHELVING**





There's a difference!

Write for Catalogs

FRED MEDART MANUFACTURING CO.
3544 DE KALB ST. ST. LOUIS, MO.
Sales Engineers in All Principal Cities — Consult Your Telephone Directory

FACTORY MANAGEMENT AND MAINTENANCE

SERVICE SECTION

Equipment—Material—Supplies *For Plant—Mill—Factory*

Industrial Consultants

SPROCKETS

45,000 in stock for block, roller and silent chains.

Special sprockets are made for your requirements.

Speed Reducers. Lathe Drives.

Write for New Catalog

CULLMAN WHEEL COMPANY

1325 Altgeld St., Chicago

ELECTRIC VALVES for AUTOMATIC CONTROL

Write for complete data on ELECTRICALLY OPERATED VALVES for automatic control of air, water, gas, oil, ammonia, etc.

May be operated by thermostat, time switch, float switch, etc. Available for A.C. or D.C. operation from ordinary lighting circuit.

ELECTRIC VALVE MFG. CO., Inc.

64 Murray St., New York, N. Y.

OLIVER FIELD ALLEN

Licensed Professional Engineer, New York State
Fellow: A.I.E.E. Member: A.S.M.E., S.A.E. Am. Chem. Soc. Soc. Am. Mil. Engrs.
Consulting Engineer
Diesel Engines. International Engineering Liaison. Gas and Oil Engine Power Applications. Regular Foreign Correspondents.
117 Liberty Street, New York City
Cable Address: OFALL-New York

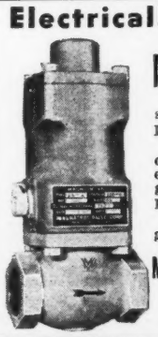
THE EMERSON ENGINEERS

30 Rockefeller Plaza, New York — 11 So. LaSalle St., Chicago

INDUSTRIAL, ADMINISTRATION AND MANAGEMENT COUNSELORS

(Since 1899)

Electrically controlled



MAGNETIC VALVES

solve many flow control problems.

For use on air, gas, hot or cold water, brine, oil, etc., Magnatrol Valves will give satisfactory and dependable service.

For detailed description get our bulletins.

MAGNATROL VALVE CORP.

52-54 Beekman St.
New York, N.Y.

CESCO WIDE VISION

PRICELESS PROTECTION

To safeguard eyes against industrial hazards, and against eye strain, is the duty of both workman and employer. Goggles that provide safety with ease are aids to efficiency. CESCO Goggles are *scientific* products. There is one for every requirement in industry.

Write for literature.

CHICAGO EYE SHIELD COMPANY

2331 Warren Blvd. CHICAGO, ILL.

FREDERICK T. HICKS

Registered Patent Attorney
Registered Professional Engineer

Ex-Member of Examining Staff of the United States Patent Office

1541 Nicholas Bldg., Toledo — Penobscot Bldg., Detroit

METHODS ENGINEERING COUNCIL, Inc.

Motion and Time Study Training for Methods Engineers
Key Man Training in Methods Study
Consultations and Installations
Booklet describing training courses for either methods engineers or keymen sent upon request.
Wood and Franklin Streets, Station 21
Pittsburgh, Pa.

"WELD-BILT" ELECTRIC HEAVY-DUTY PORTABLE ELEVATORS

Built to meet modern economic standards for material handling. Steel, arc-welded construction, automatic electric control. Have Weld-Bilt geared-head motor and oil-sealed hoist unit with built-in electric magnetic brake. Have full safety features. Available for any practical capacity and service. Write.

WEST BEND EQUIPMENT CORP.

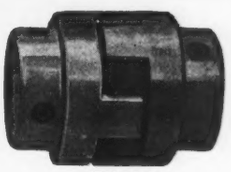
Material Handling Engineers

West Bend, Wisconsin

Type IA

L-R

Everlasting FLEXIBLE COUPLING



(Patented)

Non-Lubricated. Quietest, lowest cost coupling made. **Write for test sample to prove it.** Give shaft diameter, H.P. and R.P.M. Type IA from 3/16" to 2¾" bores.

LOVEJOY TOOL WORKS

4963 W. Lake St. Chicago, Ill.

ALLAN H. MOGENSEN

Industrial Consultant

330 W. 42nd Street
NEW YORK CITY

MORRIS & VAN WORMER

INDUSTRIAL ENGINEERS

Management
Financial Problems

52 Wall St. New York, N. Y.

SPEED RECORDERS

HASLER TEL

ALSO SPEEDOMETERS WITH "RUNNING TIME" COUNTERS

R.W. Cramer & Co. 67 Irving Place, New York, N.Y.

PULMOSAN RESPIRATORS

Protection against

DUSTS FUMES GASES SMOKE SPRAY MISTS SANDBLASTING

Write for Details

PULMOSAN SAFETY EQUIPMENT CORP.
176 Johnson St. Brooklyn, N. Y.

The Trend Toward Economy—

The service of the consulting engineer is a real economy. With his knowledge of organization and production problems and his wide and varied experience, he can usually reveal the points of waste and inefficiency that are costing you money and suggest inexpensive means for their elimination.

Do You Use Your Own Product?

If so, how many plants represented by the thousands of readers of Factory Management and Maintenance could use it too (and would BUY it) if your advertisement appeared here?

SEARCHLIGHT SECTION

EMPLOYMENT BUSINESS OPPORTUNITIES EQUIPMENT—Used or Special

UNDISPLAYED—RATE PER WORD

Positions Vacant and other classifications—15 cents a word, minimum charge $3.00 an insertion. Allow 10 words for box address. No additional charge for forwarding replies.

Positions Wanted (full or part-time salaried employment only), ½ the above rates.

Discount of 10% for payment in advance on 4 consecutive insertions of undisplayed advertisements.

Proposals—50 cents a line.

DISPLAYED—RATE PER INCH:

1 inch $8.00
2 to 3 inches ..... 7.80 per inch
4 to 7 inches ..... 7.60 per inch

Other spaces and contract rates on request.

An advertising inch is measured vertically on one column, 3 inches—30 inches—to a page.

COPY FOR NEW ADVERTISEMENTS RECEIVED UNTIL THE 18TH OF THE MONTH FOR THE ISSUE OUT THE FOLLOWING MONTH.

POSITION VACANT

CIVIL ENGINEER WANTED—Should have 5 to 10 years' experience in heating ventilating, maintenance engineering and structural design. Application should give full details of experience, training, references, small photograph. P-364, Factory Management and Maintenance, 330 West 42d Street, New York City.

EMPLOYMENT SERVICE

We specialize in Specialists. No advance fees to employees. No obligation to employers. Inquiries invited. Established 22 years. Harrison Personnel Service, 20 W. Jackson Blvd., Chicago.

POSITIONS WANTED

CLEAN CUT progressive college graduate, 27, valuable as aid to executive. Engineering management, design, and business administration experience. Skilled statistical draftsman and analyst. Excellent references. Anywhere. P. K. Cheuse, 880 East 26th Street, Brooklyn, N. Y.

MAN WITH EXECUTIVE ABILITY is seeking a new connection. Formerly secretary and treasurer of successful paper specialty manufacturer with 15 years' experience in financial and factory accounting; budgetary control; cost work; Federal and State taxes; coordination of inter-departmental accounting systems, etc. Four years' experience in public accounting. Well versed in industrial engineering practices and procedures; the Social Security Act; Robinson-Patman Act. Received his legal training at the Y.M.C.A. Law School, technical training at the Ohio Mechanics Institute and studied a special technical course at Harvard University. His age is 40 and married. If interested in such a man, please address: G. H. Landwehr, 3008 Springer Ave., Cincinnati, Ohio.

ELECTRICAL ENGINEER experienced in transmission, distribution design, estimates, motor rewinding, transformer rebuilding and load checks, maintenance and electricial oil well pumping experience, details upon request. Available Jan. 1st. PW-363, Factory Management and Maintenance, 520 No. Michigan Ave., Chicago, Ill.

MECHANICAL SUPERINTENDENT—Seeking position with concern manufacturing cement-asbestos shingles, siding and similar products. Have extensive knowledge of machinery and equipment and modern methods of manufacturing. Experienced in designing new equipment and working out new methods. PW-366, Factory Management and Maintenance, 520 No. Michigan Ave., Chicago, Ill.

PRODUCTION ENGINEER AND ACCOUNTANT—Twelve years' mechanical and production experience, metal industries, eight years' executive capacity. Employed. PW-365, Factory Management and Maintenance, 330 West 42d Street, New York City.

SALARIED POSITIONS

$2,500 to $25,000

This thoroughly organized advertising service of 26 years' recognized standing and reputation carries on preliminary negotiations for positions of the caliber indicated, through a procedure individualized to each client's personal requirements. Several weeks are required to negotiate and each individual must finance the moderate cost of his own campaign. Retaining fee protected by a refund provision as stipulated in our agreement. Identity is covered and, if employed, present position protected. If you have actually earned over $2,500, send only name and address for details.

R. W. BIXBY, INC.
276 Delward Bldg., Buffalo, N. Y.

EXECUTIVES AND TECHNICAL MEN

Contact selected employers in any territories through our confidential and effective methods. Established 22 years. Write.

THE NATIONAL BUSINESS BOURSE
H. H. HARRISON, Director
20 W. Jackson Blvd., Chicago

SELLING OPPORTUNITIES

OFFERED—WANTED

Selling Agencies—Sales Executives
Salesmen—Additional Lines

OPPORTUNITY WANTED

SALES LEADS for many products can be found in the reports of nation-wide industrial and commercial buildings and public works construction published in the McGraw-Hill Construction Daily. Sample mailing free, with rates and full information on request to Manager, Business News Dept., 330 West 42d Street, New York, N. Y.

We Will Negotiate with MANUFACTURERS' AGENTS

who are established with industrial clients, to represent us in a few limited territories.

Our insulation products are sold to industrial accounts having low temperature and sound problems. We pioneered and grew as a potent factor in certain industrial fields.

In writing, please outline your present connections and activities. After preliminary correspondence, if we are mutually interested, an executive of our company will visit you.

Address:

RW-367, Factory Management & Maintenance
520 No. Michigan Ave., Chicago, Ill.

FOR SALE

AIR CONDITIONING APPARATUS

1—**Standard Carrier Panel Room,** constructed throughout of metal with two inches of insulation between inner and outer metal. This room consists of sides and top and is equipped with two (2) doors, each measuring 39" wide by 6'-3" high.
Room measures 16'x9"x14'-8"x8'-1" high and rests on four inch (4") machinery corkboard.
1—**Carrier-Brunswick** two-cylinder, 4" bore by 3" stroke, **Ammonia Refrigeration Compressor,** complete with
1—7½ HP., 1750 R.P.M., 220 volt, 3 phase, 60 cycle **Motor** for driving same.
1—**Compressor Drive.**
1—**Shell Type Condenser.**
1—**Oil Pot.**
2—**Pressure Gauges.**
All of the necessary **high side Piping.**
The necessary **Hand Switch** with thermal protection for compressor motor.
The necessary **Expansion Valve,** scale trap, high pressure cut-out, automatic water valve, and
1—**Thermostat** of the **insertion** type for stopping and starting compressor.
1—**Carrier-York Tower Type Unit Air Conditioner,** Standard No. 1722, complete with fan, fan motor, casing, direct expansion coils, brine spray pump and pump motor, together with all the necessary recirculating brine piping.
All of the necessary **Carrier Ejector Nozzles,** ejector nozzles headers and galvanized iron duct work to make same complete.
1—**Aluminum Relief Damper.**
1—**Diamond Mesh Return Grill.**
1—**Belt Guard.**
The necessary fresh and return **Air Dampers.**
1—**Automatic,** type "P", **Thermostat** for the automatic control of dampers and valves.
The necessary lever **Air Motors** and angle duct **Thermometers.**
1—W-102 **Air Compressor** complete with tank, piping and fittings necessary to make the automatic control system complete.

Bought New, Used Less Than 30 Days; Ideal for Store, Theatre, Office, Cooling and Conditioning.

GLASCOCK BROS., MFG., CO.
MUNCIE, INDIANA

MOTORS
3 Phase, 60 Cycle

H.p.	Type	Speed
850	G.E. syn.	720
600	G.E. sl. rg.	257
600	Al. Chalmers	450
500	G.E. syn.	1200
500	West. syn.	720
450	West.sl.rg.	875/700
400	G.E. sl. rg.	390
400	West. syn.	720
400	West. sl. rg.	290
400	G.E. sl. rg.	505
400	West. sl. rg.	514
400	G.E. sl. rg.	885
300	Al. Ch. sl. rg.	585
250	West. sl. rg.	700
250	G.E. sl. rg.	257
225	El. Mchy. syn.	450

DIESEL ENGINE GENERATOR SETS
200 H.P. McIntosh & Seymour, 8 cy. V-type Diesel, 500 rpm, direct con. 135 KW, DC. G.E. gen. Note. Can furnish AC gen.

ROTARY CONVERTER
1—550 K.W. G.E. Type HCC, 250 v. D.C. 6 phase, 60 cycle, 1200 rpm.

CENTRIFUGAL PUMPS
2500 GPM. Delaval type 10,59', 175 lb. 10". S. Stage, D. Suction.

Above are a few of our stock items.

BELYEA CO., INC. 144 W. 18th St. New York City
REBUILT GUARANTEED

We
- Sell
- Buy
- Rent
- Repair
- Exchange
- All Makes
- and Sizes

GREGORY HI-GRADE-REBUILT

MOTORS
GENERATORS
TRANSFORMERS
METERS, FANS,
PUMPS, ETC.

Always Dependable — Economical —

Money-Back Guarantee

GREGORY ELEC. CO.
1602 So. Lincoln St., Chicago

WANTED

STEEL BUILDINGS

& STRUCTURES
ANY SIZE OR LOCATION
ALSO PLANTS AND EQUIPMENT
Are you in the market for any Buildings?
IRON & STEEL PRODUCTS, Inc.
Railway Exchange, Chicago
"Anything so long as it contains Iron or Steel"

ALTERNATORS

1—1000 KW. G.E., 257 R. P. M.
1—500 KVA. El. Mchny., 514 R. P. M.
1—375 KVA. G.E., 225 R. P. M.
1—250 KVA. Al.-Ch., 900 R.P.M.
1—200 KVA. G.E., 800 R.P.M.
1—100 KVA. G.E., 600 R.P.M.
1—150 KVA. G.E., 600 R. P. M.
1—62½ KVA. Wgse., 1200 R.P.M.
1—25 KVA. G.E., 1800 R. P. M.

M.-G. SETS

1—500 KW. 250-V. gen., to Syn. Motor.
1—300 and 1—200 KW. G.E. 230-V. D.C. Synchr. sets.
2—100 KW. Crock.-Wheel. 250-V. D.C. to 150 H.P. Crock.-Wheel. Motors.
2—75 KW. G.E., 125-V. D.C. Induc. sets.
2—50KW. Crock.-Wheel. same.

PLATERS

1—2000/4000 amp. 6/12-V. Bennet O'Connell modern unit.
1—Same, Burke.
1—1500/750 amp. 6/12-V. Han.-Van Wink., to 20 Hp. induc.
1—1350 amp. 6 volt Rochester.

SYN. MOTORS

1—750 HP. Elec. Machy., 514 R.P.M., Unity P.F. (500 HP. at .8).
1—288 HP. G.E., ATI, 600 R.P.M. Unity PF. (225 HP. at .8).
1—150 HP. Al.-Chal. 600 R.P.M.
1—75 HP. G.E., IPF, 1200 RPM.

D.C. MOTORS

1—400 HP. Crock.-Wheel. 230-V., 575 R.P.M.
1—150 HP. G.E., RC., 230-V., 850 R.P.M.
1—130 HP. G.E., CL, 230-V., 720 R.P.M.
1—115 HP. G.E., DLC. 115-V., 850 R.P.M.

SLIP RINGS R.P.M.

1—1000 HP. G. E., MT. 300
2—500 HP. G. E., MT. 450
1—300 HP. G. E., IM. 1200
1—300 HP. Al. Chal., ANY, 514
1—200 HP. Burke, E.M.V., 900
3—150 HP. G. E., 1-M, 600

BARGAINS

1—1150 C.F.M., Bury Air Compressor.
2—1250 HP. Nordberg-Westghe., A.C. gen. units.

TURBO-GEN.

1—300 KW. De Laval-Crock.-Wheel., 230-V. D.C., condens. unit. Also 1—300 KW. G.E., A.C., non-cond.
1—625 KW. G.E., A.C. cond.

SQUIRREL CAGE

H.P.	MAKE	TYPE	RPM.
1 500	Wgse.	CS	400
2 300	Gen.Elect.	KT	360
2 200	Wgse.	CCL	1200
1 150	Al.Chalm.	AN	1200
1 100	G. E.	IK	1800
1 100	Al.-Chal.		600
1 100	Gen. Elec.	IK	1800
1 100	Wagner	31BWP	1200
1 75	Northwestern		1800
1 75	Ideal	A	900
1 75	Gen. Elec.	IK	720
1 60	Gen. Elec.	IK	720
1 60	Amer.	Tot.Encl.	900
1 50	Wgse.	CCL	1200
3 50	Gen. Elec.	IK	900
1 40	Gen. Elec.	FT	3600
3 40	Wgse.	MS	1200
2 30	Wagner	Linestarts	

AIR CONDITIONER

1—90 ton Mod. Unit. Complete.

Send for New 56-page catalog Motors, M-G Sets, Generators, Pumps, Blowers, Platers, Welders, etc.

CHICAGO ELECTRIC COMPANY

1326 West Cermak Rd., Chicago, Ill.

MOTOR GENERATOR SETS

1—200-kw., 125-v., 1200 r.p.m., G.E., type MPC connected to type TS, 300-hp., 2300/440-v., 60-cy., syn. motor.
1—125-kw., 125-v., 1200 r.p.m., G.E., type MPC connected to type ATI, 165 kva., .8PF, 220/440-v., 60-cy., syn. motor.

A.C. GENERATORS

1—330-kva., 900 r.p.m., 240-480-v., G.E.
1—300-kva., 900 r.p.m., 240-480-v., Al. Chal.
1—225-kva., 900 r.p.m., 2300-v., G.E.
1—225-kva., 600 r.p.m., 2300-480-240-v., G.E.
1—112½-kva., 900 r.p.m., 240-480-v., G.E.
1—112½-kva., 1200 r.p.m., 2200-480-v., G.E.
1—112½-kva., 600 r.p.m., 2200-480-240-v., G.E.
2—100-kva., 900 r.p.m., 240-480-v., Croc. Wheel.
1—100-kva., 900 r.p.m., 240-480-v., Westghse.
1—62½-kva., 600 r.p.m., 2300-240-480 v., G.E.
1—20 kva., 1200 r.p.m., 220/127 v., Westghse.

STEPHEN HALL & CO., INC.
693 Adams St., Hoboken, N. J.

ELECTRICAL MACHINERY

Motors and Generators, A.C. and D.C. for sale at Attractive Prices. Large Stock. New and Rebuilt. All Guaranteed. *Write for Stock List and Prices.*

V. M. NUSSBAUM & CO.
FORT WAYNE, IND.

TRANSFORMERS

A Complete Stock. **Prompt Shipment.**

3—500 KVA Wagner Transformers, 60 cycle, 4000—460 volts **$800.00** EACH

We Rewind, Repair and Redesign all Makes and Sizes.
ALL TRANSFORMERS GUARANTEED FOR ONE YEAR.
Write for Catalog No. 131-D

THE ELECTRIC SERVICE CO., INC.
"AMERICA'S USED TRANSFORMER CLEARING HOUSE"
STATION M CINCINNATI, OHIO

SHOP BUILDINGS
NEW, NEVER ERECTED

5—Units 89'x600' 2—Units 44'x445'

Also GOOD USED Structures

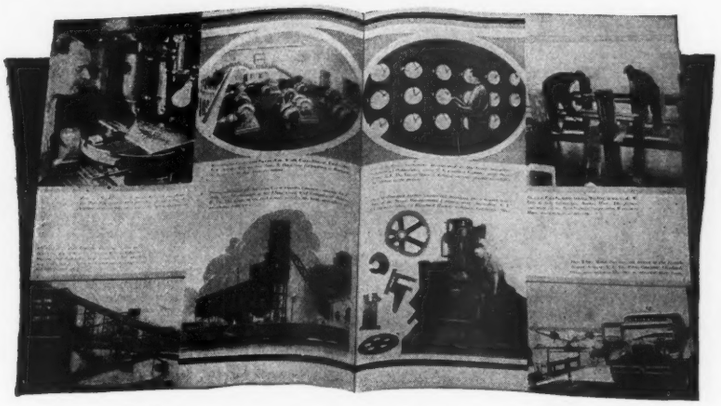
70'x325'; 90'x170'; 73'x290'
76'x332'; 60'x100'; 60'x300'

We can adapt buildings to suit your requirements.

"Buyers & sellers of steel buildings of all kinds"

IRON & STEEL PRODUCTS INC.
RAILWAY EXCHANGE, CHICAGO, ILL.
"Anything so long as it contains Iron or Steel"

PHOTOGRAPHS



made on the job tell the story!

ACTION PICTURES . . . .
PRODUCT ILLUSTRATIONS
EQUIPMENT PHOTOGRAPHS
INSTALLATION SCENES
PROGRESS PHOTOGRAPHS

Send for this descriptive folder

FIELD PHOTO SERVICE
McGraw-Hill Publishing Company, Inc.
330 WEST 42nd STREET, NEW YORK

WHETHER it's a product or piece of equipment to be sold, a report to be illustrated, or the progress of a job to be recorded, actual photographs tell the story better than words . . . Here is a photographic service prepared to secure first class pictures, promptly and at minimum cost, through carefully selected commercial photographers in all parts of the United States and Canada.

INDEX TO ADVERTISEMENTS

	Page
Acme Steel Company	127
Ahlberg Bearing Co	91
Alemite Div. Stewart-Warner Corp.	83
Alexander Brothers, Inc.	144
Allen, Oliver Field	165
Allis-Chalmers Mfg. Co	142
American Automatic Elec. Sales Co.	157
American Cyanamid & Chemical Corp., Structural Gypsum Division	161
American Hot Dip Galvanizers Assn.	110
American Optical Company	96, 97
American Steam Pump Co	160
Anaconda Wire & Cable Co.	106, 107
A. P. W. Paper Co	164
Auburn Button Works	164
Bakelite Corporation	4th Cover
Baker-Raulang Company	148
Baldwin-Duckworth Chain Corp.	84
Barber Company, Inc.	140
Bassick Company	89
Benjamin Electric Company	109
Bijur Lubricating Co	79
Black & Decker Mfg. Co	75
Blaw-Knox Company	124
Buffalo Forge Company	153
Buffalo Pumps, Inc	119
Bull Dog Electric Prod. Co	6
Bunting Brass & Bronze Co	140
Burgess Battery Co	138
Carnegie-Illinois Steel Corp	128
Carrier Corp.	147
Central Iron and Steel Co	16
Century Electric Company	104
Chicago Eye Shield Co	165
Chicago Rawhide Mfg. Co	84
Clarage Fan Company	145
Cleveland Worm and Gear Co.	116
Cling-Surface Company	88
Cochrane Corp.	160
Columbia Elec. Mfg. Co	156
Coppus Engrg. Corporation	82
Cramer & Company, Inc., R. W.	165
Crane Co.	122
Cullman Wheel Company	165
Darnell Corporation, Ltd	156
Dayton Rubber Mfg. Co	101
De Vilbiss Company	81
Dixon Crucible Co., Jos	138
Dodge Mfg. Corporation	102, 103
Electric Controller & Mfg. Co	141
Electric Valve & Mfg. Co	165
Emerson Engineers	165
Fairbanks, Morse & Co	112
Fedders Mfg. Co	86
Federal Products Corp	78
Foxboro Company	22
Frigidaire Corporation	130
Garlock Packing Co	146
Gates Rubber Company	121
General Electric Company	10, 11, 114, 135
G. E. Co. (Merchandise Div.)	14
G. E. Vapor Lamp Co	26
Goodrich Company	18, 132
Goodyear Tire and Rubber Co.	28, 29
Graybar Electric Company	7
Grinnell Company	95
Gulf Refining Company	133
Harnischfeger Corporation	77, 80
Hickok Electrical Instrument Co.	143
Hicks, Frederick T	165
Hyatt Roller Bearing Co	5
Industrial Brownhoist Corp	143
Industrial Controller Div. of Square D	3rd Cover
Jeffrey Mfg. Company	23
Johnson Gas Appliance Co	162
Jones & Laughlin Steel Corp	27
Keasbey & Mattison Co	137
Kidde & Company, Walter	90
Kinnear Mfg. Company	86
Leeds and Northrup Co	117
Leipzig Trade Fair, Inc	134
Lincoln Electric Co	17
Linde Air Products Co	163
Link-Belt Company	4
Logan Company	85
Lovejoy Tool Works	165
Macwhyte Co.	145
Magnatrol Valve Corp	165
Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc.	105
Master Electric Company	125
McCaskey Register Company	139
McGraw-Hill Book Co	152
Medart Mfg. Company, Fred	164
Methods Engrg. Council, Inc	165
Modine Mfg. Company	98
Mogenson, Allan H	165
Morris & Van Wormer	165
Morse Chain Company	24, 25
Muralo Co., Inc	146
National Chem. & Mfg. Co	111
National Super Service Co	86
New Departure Mfg. Company	34
Norma-Hoffmann Bearings Corp.	146
Norton Company	126
Osborn Mfg. Company	9, 15
Paasche Airbrush Company	154
Parks-Cramer Company	30
Pittsburgh Steel Co	90
Power Transmission Council	32
Pulmosan Safety Equip. Corp	165
Pure Oil Company	87
Pyroil Company	136
Reeves Pulley Company	131
Reliance Electric & Engrg. Co	129
R L M Standards Institute, Inc	19
Rockbestos Products Corp	162
Ryerson & Son, Inc., Jos. T	76
Searchlight Section	166, 167
Seneca Wire and Mfg. Co	136
Service Caster and Truck Co	158
Service Section	165
Shafer Bearing Corporation	113
Shepard Niles Crane & Hoist Co.	138
Signode Steel Strapping Co	154
Socony-Vacuum Oil Co., Inc.	99, 100
Sonneborn Sons, Inc., L	159
Spencer Turbine Company	152
Spring Washer Industry	33
Square D Company	3rd Cover
Standard Conveyor Co	155
Standard Oil Co. of Indiana	2nd Cover
Standard Pressed Steel Co	134
Sturtevant Company, B. F	120
Taylor Instrument Cos	20, 21
Texas Company	92, 93
Thermoid Rubber Co	118
Trane Company	160
Trico Fuse Mfg. Co	108
Tubbs Cordage Co	149
Underwood Elliott Fisher Co.	115
Union Carbide & Carbon Corp.	163
Union Drawn Steel Co.	31
U. S. Rubber Company	12, 13
U. S. Steel Subsidiaries	128
Veeder-Root, Inc.	140
Wellington Sears Co	8
West Bend Equipment Corp	165
Western Precipitation Company	149
Westinghouse (Lighting Div.)	123
Weston Electr. Instrument Corp.	136
Wiegand Company, Edwin L	164
Wood's Sons Company, T. B	152
Yale & Towne Mfg. Co	94
Young Radiator Co	156

▼

INDUSTRIAL CONSULTANTS... 165

▼

SEARCHLIGHT SECTION

Classified Advertising

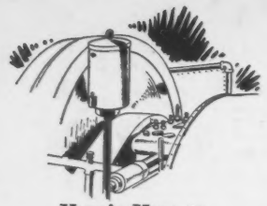
CLASSIFICATION	Page
Employment Agencies	166
Employment Service	166
Positions Vacant	166
Positions Wanted	166
Sales Opportunities	166
Equipment New and Used	166-167
Belyea Co., Inc	166
Chicago Electric Co	167
Electric Service Co., Inc	167
Glascock Bros. Mfg. Co	166
Gregory Electric Co	166
Hall & Co., Inc., Stephen	167
Iron & Steel Products, Inc	166-167
Nussbaum & Co	167

Factory

Management and Maintenance

Personnel Management—a Special Section

Turn to the Green Pages Just Inside the Back Cover



Here's How to MAKE SAVINGS NOW for all of 1937

Check these products. Take advantage of the wide experience of a Standard Oil Lubrication Engineer to determine just where they can be used in your plant. Then keep tab on the results you obtain *each month* in 1937—results measured in terms of continuous improved machine performance, reduced power loss, reduced maintenance costs, and elimination of breakdowns.

NONPAREIL TURBINE OIL—the only turbine oil in the world with an unlimited guarantee. To the user this guarantee means absolute protection against high lubrication, cleaning and drain costs.

STANOIL NO. 18-95—unusually high stability, excellent demulsibility, low pour test, good viscosity index, low carbon-forming tendency, excellent color.

NONPAREIL DIESEL OIL—made in three grades: Medium, Heavy and Extra Heavy. It is a highly refined, pure mineral oil of exceptional cleanliness, excellent stability and a good rate of separation from water. Can be used effectively for power and air cylinder as well as bearing lubrication.

STANOCYL CYLINDER OIL—atomizes quickly and perfectly, giving uniform distribution over valves and cylinders; adheres especially to wet surfaces with a film that is not displaced by water.

SUPERLA GREASES—highest grade greases made. They are free from grit and corrosive substances and more stable in storage than other cup greases.

CALUMET COMPOUNDS—12 grades, for gears.

ACME AND PREMIER CUTTING OILS

SUPERLA SOLUBLE OILS

STANDARD COAL SPRAY OIL

A Free Library of Lubrication Monographs

To help those who are responsible for machines or machinery in the plant, Standard Oil has available a growing library of lubrication monographs prepared by its Engineering Staff. These booklets contain practical tips and suggestions, discussions of basic problems and proved advice on how to solve them. Send for those you desire or for information on other types of lubrication. Just write to Standard Oil Company, (Indiana), 910 South Michigan, Chicago, Illinois.

Here are just a few of these monographs.

"Lubrication in Gear-Cutting Operations"
"Lubrication in Grinding Operations"
"Lubrication of Shovels and Draglines"
"Mine Car Lubrication"
"Paper Machine Lubrication"
"Diesel Cylinder Lubrication"
"How to Cut Coal-Handling Costs (Stoker Lubrication)"
"Steam Engine Lubrication"
"Steam Turbine Lubrication"

"John, do you mind? I didn't want to bother you with these little things before . . ."
"Hello Pop, resting?"
Funny noise in electric fan—
Pantry door hinges squeak—
What can we do about: transom rods—piano stool?
Would STANORUST save those things in the basement?
CORRECT LUBRICATION NEEDED FOR
1. DELIVERY WAGON
2. BIKE
3. NEW CATCHER'S MIT

It looks like a *busy Holiday* for this LUBRICATION ENGINEER!

PUT away that stamp collection, John—you're about to be the handy-man-around-the-house! Don't blame the family for this interruption to your holiday—blame the business you're in! As a Standard Oil Lubrication Engineer you're just too darned useful in too many different ways!

Fifty weeks of the year John's job keeps him busy as a Good Samaritan to industry. He is always on call to "shoot trouble" on lubrication, whether the problem is large or small. Broad, practical education, and years of experience in the field, have prepared him for the consistent success which is so profitable to the plants to which he is called.

Frequently his work takes on a more progressive twist than that of mere trouble-shooting. He's called in to *dig up trouble*—to uncover costly practices which may have been "getting by" from the standpoint of lubrication, but which actually have been gouging real chunks out of profit.

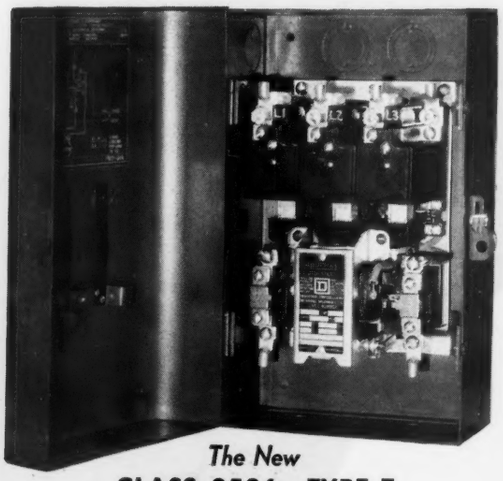
Lubrication surveys of this sort cost a plant nothing, carry no obligation, and result in real savings often enough to convince plant men and lubrication engineers, both, that the work "John" does is tremendously worthwhile!

Copr. 1936, Standard Oil Co.

STANDARD OIL COMPANY (Indiana)

CORRECT LUBRICATION

Accessibility of all parts is a SQUARE D feature



The New
CLASS 8536—TYPE T
Automatic Electric Motor Starter

■ **Here is a starter that meets all requirements of the production manager and maintenance engineer. It is readily accessible for better inspection and low maintenance cost.**

1 **The starter panel is mounted on a swing-out base for easy wiring.**

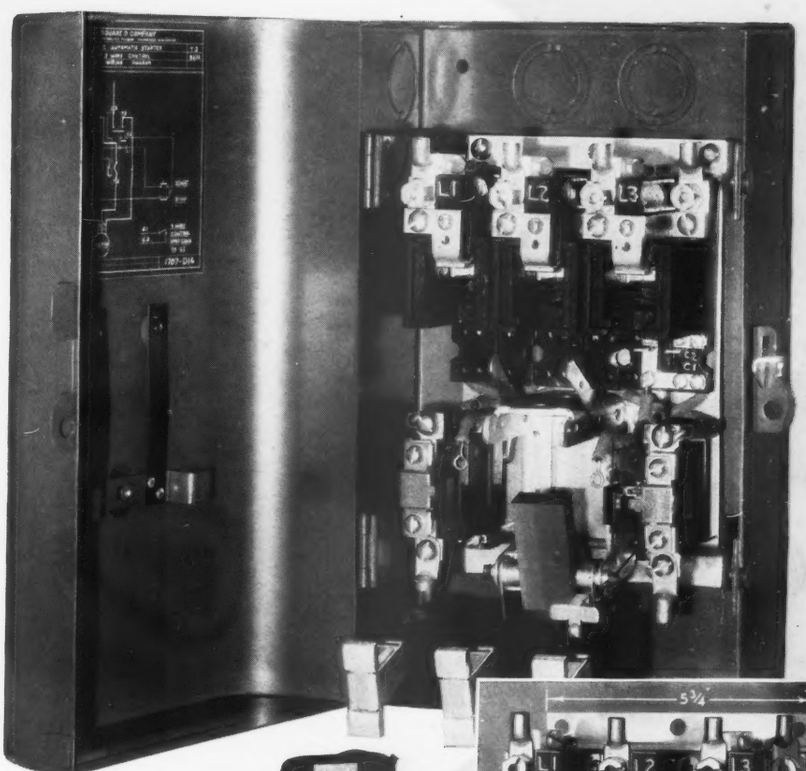
2 **All terminals are substantial and conveniently located.**

3 **Stationary and movable contacts can be inspected or replaced without disconnecting any wires.**

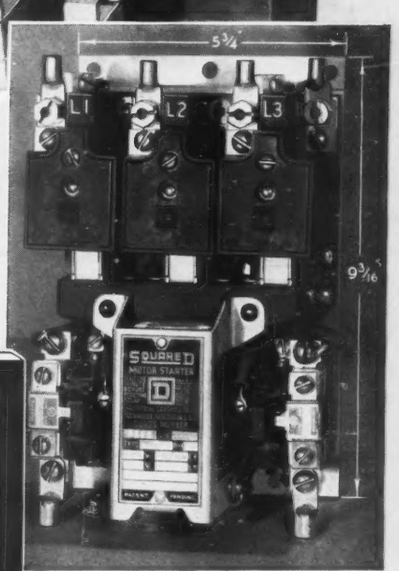
4 **Taking out one screw each removes the arc chamber cover and entire movable contactor assembly moves forward, exposing magnet core and coil.**

5 **For machine tool control applications the starter panels may be mounted side by side on 7" centers or one above the other on 11" centers.**

Investigate the advantages of this new starter. Write for bulletin 132 which describes it in detail.



Contactor assembly swung forward, all contacts exposed, magnet core and magnet coil removed.



Starter panel, 15 HP, 220 V or 25 HP, 440-550 V. Note dimensions.

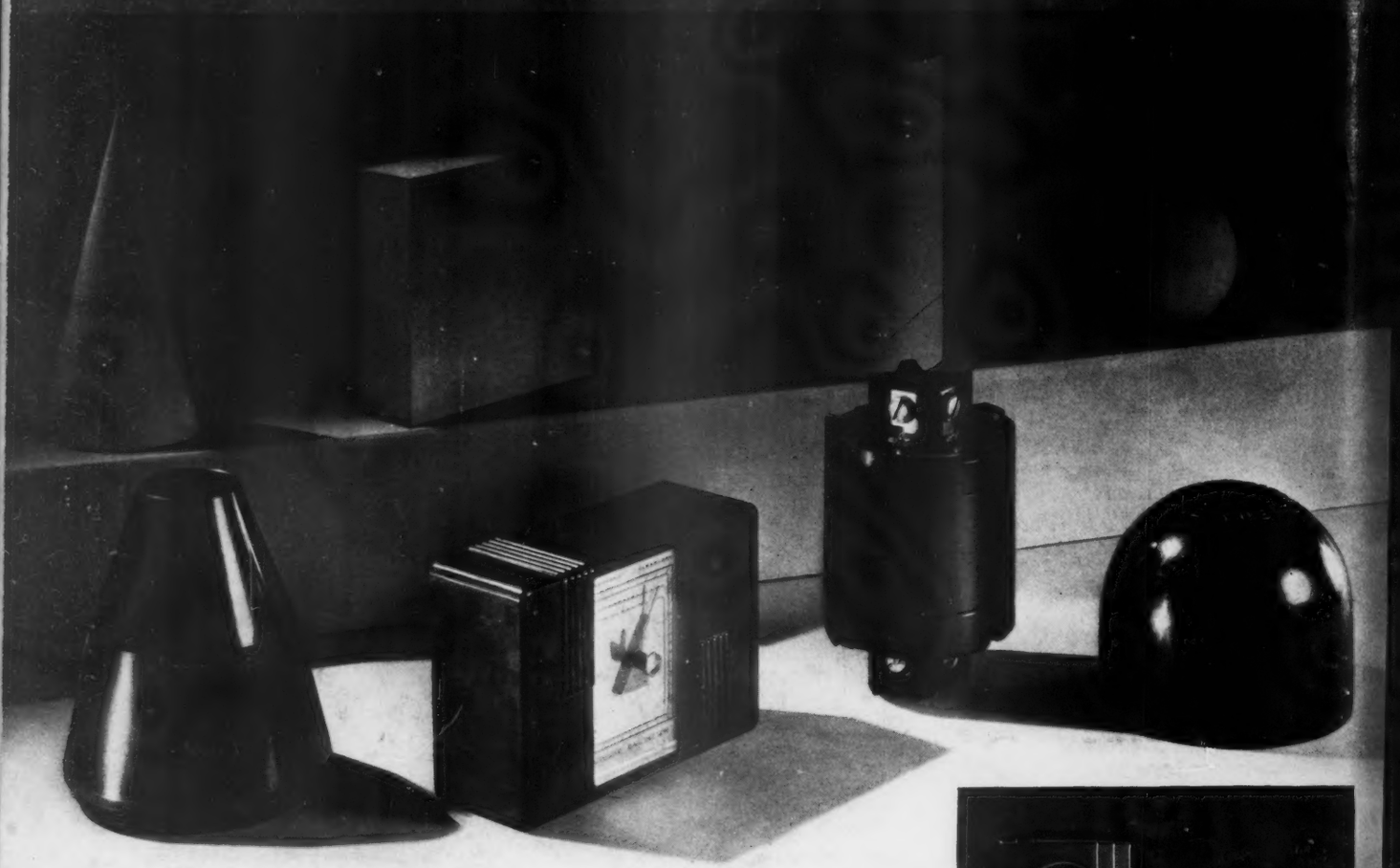
SQUARE D COMPANY

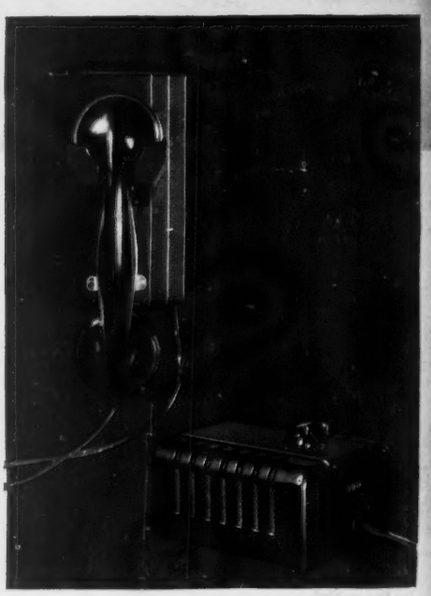
DETROIT - MILWAUKEE - LOS ANGELES

SQUARE D COMPANY CANADA LTD. TORONTO, ONTARIO

CALL IN A SQUARE D MAN

In Plastic Molding
always strive for Simple Forms

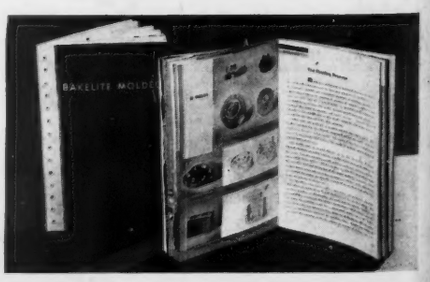




SKILLED artists and engineers recognize the value of simplicity. One knows that excessive embellishment is disturbing, and the other that intricate mechanical design implies complications. Because of the fact that the simpler forms are far more economical to reproduce by plastic molding, the widespread use of Bakelite Molded has played a very definite part in the simplified designs so apparent today in many new and redesigned products.

When designing articles or parts to be made of Bakelite Molded, striving for simplicity is not only good business from a production cost standpoint, but usually results in a better and more saleable product. Right at the very beginning, when a new article or device is in the idea stage, is the time to consult us, or your custom molder, with regard to its design and construction. Sometimes, out of our long experience, a slight change may be suggested that will be a real improvement as well as an economy.

Our engineers are always glad to cooperate with manufacturers in solving plastic molding problems, and welcome inquiries. You also will find much of interest in the 48-page illustrated booklet 16M, "Bakelite Molded", and we will gladly mail a copy promptly on receipt of your request.



BAKELITE CORPORATION, 247 PARK AVENUE, NEW YORK, N. Y.
BAKELITE CORPORATION OF CANADA, LTD., 163 Dufferin Street, Toronto, Ont.

BAKELITE

REGISTERED U. S. PAT. OFF.

"The registered trade marks shown above distinguish materials manufactured by Bakelite Corporation. Under the symbol "B" in the numerical sign for infinity, or unlimited quantity, it symbolizes the infinite number of present and future uses of Bakelite Corporation's products"

THE MATERIAL OF A THOUSAND USES